WORK PLAN

PHASE II REMEDIAL INVESTIGATION

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

Prepared For:

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PENNSYLVANIA

Prepared By:

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COLCHESTER, CONNECTICUT

ATLANTIC PROJECT NO.: 1256-18
NAVY CONTRACT NO.: N62472-88-C-1294
AMENDMENT NO.: P00018

MAY 1993

ATLANTIC

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geologists
scientists

MEMORANDUM

TO: Members of the Technical Review Committee (TRC)
for the Installation Restoration Study
at the Naval Submarine Base - New London (NSB-NLON)
Groton, Connecticut

FROM: Paul Burgess, Principal
Barry Giroux, Project Manager

DATE: May 27, 1993

RE: Phase II Remedial Investigation
Atlantic Project No.: 1256-18

On behalf of the United States Navy, Northern Division Naval Facilities Engineering Command, enclosed is a copy of the final Work Plan, Field Sampling Plan, QA/QC Plan, and Health and Safety Plan for the Phase II Remedial Investigation, Installation Restoration Study, Naval Submarine Base — New London, Groton, Connecticut.

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NAVY RESPONSES TO EPA COMMENTS (MAY 5, 1993) ON THE REVISED DRAFT PHASE II REMEDIAL INVESTIGATION WORK PLAN (MARCH 1993)

INTRODUCTION

These responses reflect discussions and agreements regarding resolutions of the comments from a phone conference on May 20, 1993 between U.S. EPA, Navy and Atlantic.

GENERAL COMMENTS

1. The Work Plan and the Field and Sampling Plans are unclear with regard to preservation aspects of samples that will be collected from the various areas of concern (AOC) at the site. The Plan needs to include a comprehensive table showing the number f environmental and QA/QC samples collected from the AOCs, the sample containers, and the preservation procedures to be used. Also, the plan needs to identify more of the field equipment that will be used in sampling activities.

   Appendix B of the QA/QC plan contains a table arranged by site which shows analyses to be performed, media to be sampled, number of samples to be collected including separate listings for field duplicates, trip blanks, equipment rinsates, field blanks, matrix spikes, and matrix spike duplicates.

   Addendum 4 of Appendix A of the QA/QC plan is a table arranged by parameter being tested, showing required sample volume and container type, preservation methods, and holding times.

   The only field equipment not adequately defined pertains to sediment sampling. The sediment sampling SOP has been revised to identify all field sampling equipment.

2. Review of the Navy responses indicated that 5 of the 16 comments raised in EPA's January 8, 1993 correspondence were deficient and are identified in the following specific comments section. Each of the specific comments concerning the Navy responses begins with a summarized statement of the original EPA comment followed by an evaluation of the Navy's response.

   No response required.

3. An objective of the Phase II Work Plan should be to adequately characterize the extent of VOC contamination in groundwater. In addition, the work plan should identify alternative sampling collection techniques in the event that utilities pose access problems during the advancement of borings. As previously recommended by EPA, the Navy

should consider the use of microwells, angle borings, and geophysical methods in performing the proposed investigations.

This comment refers specifically to the Lower Subase and is discussed below in our response to comment 23.

4. There are a few points where the text and figures either do not agree, or require clarification. In addition, the specific analysis methods to be used for the TAL and TCL in surface water and sediments should be included in the final work plan.

These concerns are addressed in responses to the following comments 18, 19, 20 and 23.

SPECIFIC COMMENTS

Section 1.0 — Introduction

5. Page 3, Figure 1-3

This is an outdated map. In accordance with Appendix III of the draft NSBNL Federal Facilities Agreement (FFA), several study areas and areas of contamination should be added to the figure. In addition, since the ball field/underground storage tanks, a.k.a. Fuel Farm, is listed in Appendix III of the FFA as a study area, why is it not an Installation Restoration Study site?

EPA had requested in its March 10, 1993 comment letter that the figure be modified to include the locations of several of these study areas/areas of contamination. All site maps in the Work Plan should incorporate these other Installation Restoration Study sites.

All study areas designated in the FFA are added to Figure 1-3.

Section 4.0 — Human Health Risk Assessment

6. Page 81, Section 4.2.1, Paragraph 1

The data evaluation section must clearly identify all sample data which are available for use in the risk assessment. This section must also identify all sample data which are excluded from further consideration in the risk assessment and indicate the reason for the exclusion.

We feel that it is premature to identify all of the data which will be available for use in the risk assessment at this point until the sampling is complete. The data which will be excluded from further consideration will be identified when the sampling is complete.

PREFACE

This document is the *Phase II Remedial Investigation Work Plan* for the Naval Submarine Base—New London. It is prepared as part of the United States Navy Installation Restoration Program. This report was developed to implement recommendations in the *Phase I Remedial Investigation Report* and to address comments raised by the technical review committee (TRC).

The first draft of this report was submitted to the TRC for review in November 1992. Written comments were received from TRC members as listed below:

- EPA — January 8, 1993;
- CTDEP — January 13, 1993; and
- Mr. Robert Fromer — March 14, 1993.

Two new sections of the work plan regarding the CBU and OBDANE sites were sent to TRC members for review on March 1, 1993. The following written comments were received:

- EPA — April 15, 1993; and
- CTDEP — March 24, 1993.

The Navy prepared detailed responses to all of these comments and prepared a revised draft for review by the EPA and CTDEP in March of 1993. The EPA submitted a letter responding to the Navy's revised draft work plan. The Navy had discussions with the EPA on May 20, 1993 to resolve outstanding issues. As a result of these discussions, an agreement was reached on the outstanding issues and documented in writing by the Navy. This report has been modified to address comments from the TRC.

The following documents pertaining to comments and responses to the draft report are provided in Attachment 1 to this preface.

- Navy Response to EPA Comments (May 5, 1993) on the *Revised Draft Phase II Remedial Investigation Work Plan* (March 1993)

- Navy Responses to EPA Comments (January 8, 1993) on the *Draft Phase II Remedial Investigation Work Plan* (November 1992)

- Navy Responses to CTDEP Comments (January 13, 1993), *Draft Phase II Remedial Investigation Work Plan* (November 1992)

- Navy Responses to Mr. Robert Fromer's Comments (March 14, 1993) on the *Draft Phase II Remedial Investigation Work Plan* (November 1992)

- Navy Responses to CTDEP Comments (March 24, 1993) on CBU and OBDANE Sections (March 1, 1993) of the *Phase II Remedial Investigation*.

- Navy Responses to EPA Comments (April 15, 1993) on CBU and OBDANE Sections (March 1, 1993) of the *Phase II Remedial Investigation*.

All revisions made to the draft report have been highlighted in this final report except for revisions to tables or figures.

7. **Page 81, Section 4.2.1, Paragraph 2**

Why will "U" qualifiers (indicating the compound was not detected) be considered adequate for risk assessment? Please explain.

The higher of the two measured contaminant concentrations from duplicate samples should be included in the risk assessment.

The Work Plan has been modified as follows: "... "U" qualifiers will be considered adequate for use in the risk assessment. The "U" qualifier indicates that the analyte was not detected in the sample and is an acceptable analytical result. If use of this sample is indicated by the exposure assumptions, and there is reason to believe that the analyte is present at a level below the SQL, then the sample will be assigned a numerical value of one half the SQL. Non-detects with "unusually high SQLs" will generally be excluded from use in the quantitative risk assessment as described in RAGS, Section 5.3.2... "

The Work Plan has been modified to read: "... Field and laboratory control samples will be excluded. The higher of the two measured values from duplicate samples will be included in the risk assessment ... "

8. **Page 81, Section 4.2.3, Paragraph 5**

The risk assessment must present the rationale for excluding a compound from the risk assessment.

Section 4.2.3 adequately describes the rationale for including a compound in the risk assessment. The rationale for excluding a compound from the risk assessment will be presented in the risk assessment.

9. **Page 82, Section 4.3.1, Paragraph 3**

This paragraph states that workers will likely be exposed to volatile organic compounds (VOCs) from soil and groundwater, but will these pathways be evaluated quantitatively? Please clarify.

The Work Plan has been modified to read: "... excavation and construction. The assessment of the groundwater inhalation and dermal contact pathways will be addressed qualitatively".

10. **Page 82, Section 4.3.3, Paragraph 5**

The geometric mean does not indicate or describe the normality of the probability distribution. Normality tests must be performed to determine if the data are normally or log-normally distributed.

We have modified the Work Plan to read: "... events which are then averaged. Average and maximum exposure point ... " by eliminating the sentence in our Work Plan on the *use of the geometric mean.*

11. **<u>Table 4-2, Exposure Summary for Potential Human Receptors</u>**

a. Why is the dermal pathway for soil exposure addressed for some receptors and not for the others? Please explain.

The dermal pathway is addressed when the receptor is exposed to soils directly.

b. Is exposure to soil vapors one of the exposure pathways? Although discussed in the text (see comment 2 above), the soil vapor pathway is not specified in this table. Also, from the report, it seems that only soil particulate and not soil vapor is actually being assessed by the Navy. Please clarify.

Exposure to soil vapors is one of the exposure pathways. These data will be determined analytically. Soil vapors will be addressed quantitatively only to receptors frequenting the Goss Cove museum.

c. Groundwater is listed as exposure point and exposure medium for many receptors, but exposure routes are not specified. The Navy has discussed the possibility of a vapor exposure for workers from VOCs in groundwater (see comment 9 above). However, in both the draft and draft final work plans, the Navy does not seem to address any inhalation pathway from groundwater for workers. Please explain.

As far as groundwater exposure, depending upon the depth of the utility lines, the utility workers might be exposed to VOCs. However, we do not have the data yet to address this. The reader is referred to the response to comment 9.

d. Outdoor air is also being listed as an exposure point, but is this pathway going to be assessed? Please explain.

Outdoor air is listed but has been corrected to encompass only particulates in air (fugitive dusts). Inhalation of outdoor air will not be addressed quantitatively.

e. Page 85 — Frequency for residential drinking water for Superfund sites should be 350 days rather than 365 days based on "standard default exposure factors", OSWER Directive 92856.03. Please revise.

The frequency has been changed from 365 days/year to 350 days/year.

f. Page 86 — Footnote "**" — What is the source for EPA's default frequency of exposure for workers at 48 days/year? EPA's default value for frequency is 250 days/year for workers based on "standard default exposure factors", OSWER Directive 92856.03.

Most of the exposure data for workers is site-specific.

g. Those pathways for which exposure points and exposure media are listed, but no exposure routes and exposure parameters are specified, should include some discussion as to whether they are going to be assessed quantitatively, qualitatively or not assessed at all.

The definition of the exposure routes and parameters is premature until the data have been collected. This will be done in the risk assessment.

12. **Page 89 through Page 91 — Exposure Equations**

The equations presented are the equations from the Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part A). However, site-specific equations should be presented. For example, soil particulate is included in the calculation for soil exposure for this site, but how is it incorporated in soil exposure equation is not shown. Moreover, if the Navy intends to assess vapors from groundwater or soil quantitatively, the modified equations for calculations of these routes should be presented. On the other hand, if outdoor air is not assessed quantitatively, why is the equation for inhalation presented? Also, where is the equation for groundwater? According to Table 4-2, groundwater is an important exposure pathway for Area A/OBDA residents through the future use scenario. Please clarify.

We have included the general intake equation as well as the intake equations for pathways for which there are currently data to support. Additional equations will be included in the risk assessment after the exposure routes have been defined.

13. **Page 93, Section 4.4.1, Paragraph 1 — Dermal Guidance**

a. Dermal exposure from soils: The following is the modified Region I Superfund dermal guidance for soils.

   TCCD: (0.1-3%) For other polychlorinated dibenzo(p)dioxins and polychlorinated dibenzofurans, use upper bound of 3% for absorption.

   TCB: (0.6-6%) Apply upper bound of 6% for all PCBs and arochlors.

   Cadmium: (0.0-1.0%) For Superfund risk assessments of dermal exposure from soils, quantitatively assess exposure and risk for the above three compounds only. For other compounds, assess qualitatively in the uncertainty section.

b. Dermal exposure from surface water: For inorganics, Kp values in Table 5-3 of dermal guidance should be used. If there is no Kp value in Table 5-3 for inorganics, then a default Kp value of water at 1×10^{-3} cm/hr should be used. For organics, Kp value in Table 5-7 of dermal guidance can be used. This is consistent with procedures developed by EPA headquarters to support the calculations for the dermally absorbed dose described in Chapters 5 and 10 of the dermal guidance. These procedures are available in spreadsheet form (on a diskette) that can be obtained from the EPA Region I Superfund Coordinator in the Superfund Support Section.

We have modified the Work Plan to include only the upper bound values for dermal absorption for soils as per Region I Superfund guidance: "... and cadmium absorbed are 3%, 6% and 1%, respectively.

"For estimating the dermally absorbed dose of inorganic compounds per event from surface water, the permeability coefficient from surface water through skin (cm/hr) can be obtained from Table 5-3 in the dermal guidance document (EPA 1992). If there are no published values for specific compounds, the default value of 10^{-3} cm/hr will be used. For estimating the dermally absorbed dose of organic compounds from surface water, the permeability coefficient from water through skin from Table 5-7 in the dermal guidance document (EPA 1992) will be used".

c. Although currently under review, EPA Region I does not require the quantitative assessment of the groundwater dermal pathway.

As per EPA Region I policy, a quantitative assessment of the groundwater dermal pathway will not be included.

14. <u>**Page 93, Section 4.4.1, Paragraph 2**</u>

The statement "EPA has withdrawn its RfDs for lead..." is inaccurate. Although EPA Region I has accepted the use of an RfD back calculated from the drinking water MCL of lead at 50 ppb in the past, there has not been an RfD for lead verified by EPA's RfD work group.

The Work Plan will be modified to read: "The U.S. EPA has accepted the use of the Integrated Uptake/Biokinetic (IU/BK) Model ..."

15. <u>**Page 94, Section 4.4.2, Paragraph 3 — Lead Uptake/Biokinetic Model**</u>

a. The text should include discussion of a lead exposure pathway for children.

In the risk assessment there will be a discussion of a lead exposure pathway in the areas of the site to which children might have access.

b. If the Navy intends to address lead exposure for adults in the uncertainty section, why has the safe blood lead level for adult not been established yet? Please explain.

There are adverse effects of lead seen in adults. There are exposure and effects data in the literature which can be used to evaluate potential toxicities to workers. A worker and not a child might be a receptor on the site. If this were the case, the calculated blood lead levels can be compared with the 10 to 15 ug/dl benchmark. If there is minimal potential for adverse health effects based upon this level, then there probably will be no potential for adverse health effects in adults.

Section 5.0 — Ecological Risk Assessment Work Plan

16. **Page 108, Table 5-1, Area A — Summary of Ecological Sampling**

In the seventh row of this column, under "Introduced Earthworms from Bioassays", there are three tissue samples to be taken from the downstream watercourses, with a footnote that this number includes three reference locations. Since the downstream watercourses would not be suitable for reference locations, and there is no mention in the text of three reference locations, it seems likely that either the number of tissue samples or the footnote is in error. Please clarify or correct these numbers.

The footnote was an error and has been removed.

Section 6.0 — Preliminary Identification of Remedial Action Alternatives

17. **Page 131, Table 6-1**

Expand the table to include the Maximum Contaminant Levels (MCLs) for bis(2-ethylhexyl)phthalate and copper.

Table 6-1 has been revised by adding copper and bis(2-ethylhexyl)phthalate.

Section 7.0 — Remedial Investigation and Feasibility Objectives

18. **Page 172, Figure 7-1 — CBU Drum Storage Area Field Sampling Plan**

According to the key in Figure 7-1, there are proposed surface soil locations. However, there are no surface soil sampling locations indicated on the figure itself. In addition, there are no surface soil sampling locations indicated in Table 7-3. If the test borings (0-2') in Table 7-3 are intended as surface soil samples, they should be indicated as such. Please clarify.

There are no proposed surface (0-6") soil sample locations at this site. Samples 1MW1S (0-2'), 1TB1 (0-2') and 1TB2 (0-2') shown in Table 7-3 are boring soil samples that will be collected from 0-2 feet below the ground surface.

19. **Page 176, Figure 7-2 — OBDANE Field Sampling Plan**

Please refer to the above comment on surface soil locations in the CBU Drum Storage Area.

Please refer to the response to comment 18 above.

20. **Page 198, Figure 7-5 — Field Sampling Plan, Goss Cove Landfill**

A sediment sample location is described in the text of this section (7.2.3, p. 199) along the bank of the Thames River north and upstream of the pier, yet south and downstream of the storm drain outfall from the ball fields. The Goss Cove Landfill Field Sampling Plan does not show this sample location. If the location described is the location requested, this sample location should be indicated in Figure 7-5.

In addition, the text needs to be revised to reflect that CLP TAL and TCL, TPH, TOC, and grain size determinations will be made.

The reference in this section of the report has been clarified to indicate that all sediment sample locations in the Thames River are shown in Figure 5-3 and listed in Table 5-2.

Table 5-2 has been revised to indicate that sample T3SD1, which is located along the bank of the river north and upstream of the pier, yet south and downstream of the storm drain outfall, will be tested for VOCs.

21. **<u>Page 210, Table 7-19</u>**

In a March 10, 1993 comment letter, EPA requested that the Work Plan be revised to ensure that surface water samples and sediment samples were collected prior to the actual draining of the lake. However, the action plans as described in the table for both water and sediment samples indicate that samples will be collected after the lake is drained. The table needs to be revised to clearly state that the water and sediment samples will be collected before the lake is drained.

As discussed during our phone conversation on May 20, 1993, these samples will be collected when the lake is drained and that the surface water sample will be collected at an area where groundwater seeps into North Lake.

22. **<u>Page 215, Table 7-21 — Area A Field Sampling Plan</u>**

The sediment samples from locations 2DSD24 through 2DSD29 are proposed at a depth of 0' to base of sediments. Benthic organisms are only exposed to contaminants in the top few inches of sediments. To best represent exposure to benthic organisms, samples should be collected at the least from the top few inches and no more than one foot in depth.

Three sediment samples are listed for groundwater seeps into North Lake, at a depth of 0 to 1 foot. Earlier Navy comments have indicated an intent to sample sediments while the lake is empty. The sediment chemistry may change in the absence of overlying water. Therefore, in order to be considered sediment samples, these samples must be taken either while the lake is full or, if desired, immediately after draining of the immediate area of the sample locations.

As discussed, the plan is acceptable as written as sediment samples in the Area A Downstream will be collected from the following intervals: 0-1', 1-3', and 3-5'. A note has been added to Table 7-2 for clarification.

Please refer to the above response (21) regarding the second paragraph of this comment.

23. **Page 228, Table 7-25**

EPA has requested in its March 10, 1993 comment letter that additional groundwater monitoring wells be installed in the area of well 13MW5 and the tanks so as to determine the extent of floating layer. Also, it was recommended that the Phase II Work Plan include provisions for the complete identification of the extent of VOC contamination in groundwater at the site.

The table shows no additional groundwater wells in the area of well 13MW5 nor does it address VOCs contamination in the groundwater. The table should be revised to show the installation of additional wells in the area of well 13MW5. The table also needs to include the determination of VOCs contamination in groundwater.

Table 7-25 has been revised to indicate that defining the extent of VOC contamination is an objective of the Phase II RI.

Wells 13MW18 and optional wells 13MW19-25 have been added to Table 7-27 to determine if free product exists near the power house (Building 29), which is where 13MW5 is located.

24. **Appendix C**

a. The average cleanup levels listed in the memorandum in Appendix C for PCBs and PAHs are said to be developed based on EPA's toxicity value and risk level. However, the cleanup levels developed and presented in the table are based on three different routes, and it is unknown as to which one is chosen for the cleanup level. For PCBs, it appears as though the cleanup level of 4 mg/kg stated in the memorandum is chosen from the ingestion route based on 10^{-5} target risk level which is 3.69 mg/kg. However, for PAHs, it is impossible to relate the 24 mg/kg average cleanup level stated in the memorandum to the cleanup level developed in the table for PAHs.

b. Page 6 of the memorandum: The statement "If a lower soils ingestion rate of 100 mg/day is assumed (as suggested by EPA's reviewers), then the target level will be 33 mg/day" is misleading, because EPA always recommends 200 mg/day soil ingestion rate for children, and 100 mg/day soil ingestion rate for adult. Also, it should be noted that cleanup level for DDTR is not presented in any table of this appendix.

c. According to equations presented in RAGS, Human Health Evaluation Manual, Part B: "Development of Risk-Based Preliminary Remediation Goals", the cleanup level for the contaminant in one medium (soil) is developed based on all the possible routes combined. For example, cleanup level for PCBs in soil for this site should be based on the equation with three routes combined. For PAHs, if dermal pathway is not applicable for soil absorption, then dermal routes should be omitted from the equation.

d. The parameters used for development of cleanup levels should be the same as the ones used for risk assessment.

e. Since the CPF of 7.3 per mg/kg/day for benzo(a)pyrene has replaced the CPF of 5.8 per mg/kg/day, it is unwise to present cleanup level based on both. The reason is that the letter is a result of a mathematical error and will unlikely be used again.

f. Lead Uptake/Biokinetic Model: It is inappropriate to present cleanup level for adult workers only. Based on the public health point of view and based on the application of Lead Uptake/Biokinetics Model to children, the priority is to develop a cleanup level of lead for children.

These cleanup levels will be revisited during preparation of the feasibility study and will be based upon the parameters used in the risk assessment and the site data. The cleanup levels will be calculated using the Risk Assessment Guidance for Superfund: Volume I — Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals). For purposes of finalizing the Work Plan, we have stated that any cleanup levels presented in the Work Plan are preliminary and are only to be used in scoping the field investigations to be performed.

FIELD SAMPLING PLAN

25. The work plan and the field and sampling plan are unclear with regard to preservation aspects of samples that will be collected from the various areas of concern (AOC) at the site. The plan needs to include a comprehensive table showing the number of environmental and QA/QC samples collected from the AOCs, the sample containers, and the preservation procedures to be used. Also, the plan needs to identify more of the field equipment that will be used in sampling activities.

A comprehensive table is provided as Addendum 4 to Appendix A of the QA/QC Plan. The plan has been modified to indicate the type of equipment that will be used for sediment sampling.

26. <u>Pages 52 and 53, Section 4.2.2.3</u>

Two rounds of air sampling are anticipated in and around the Nautilus Museum Building. Each round will consist of three samples. Duplicate sampling requirements are not indicated. At least one sampling event must be collected in duplicate according to the procedure outlined in Section 8.2 of Atlantic Environmental's SOP No. 1256-D.

Appendix B of the QA/QC Plan has been revised to indicate duplicate sampling during each air sampling event.

27. **Page 53, Section 4.2.2.4**

EPA has requested in its March 10, 1993 comment letter that a complete round of monthly water level measurements be obtained from all monitoring wells on the base to produce a series of groundwater elevation maps. However, the text in the draft final work plan does not indicate that such samples will be collected nor is such collection identified in accompanying tables for this section. The text or tables need to be revised to show that a complete round of monthly water level measurements will be made for all monitoring wells on the base.

Table 4-2 in Section 4.1.16 of the Field Sampling Plan shows the wells that will be monitored on a monthly basis for groundwater elevation.

28. **Page 71, Section 4.2.3, Paragraph 5**

Based on previous telephone conversations between the Navy, CTDEP and EPA, it is EPA's understanding that several additional monitoring wells were to be installed during the Phase II investigation, upgradient of the downstream watercourses/downgradient of the pistol range to better define groundwater quality in the downstream watercourse area. However, the installation of these additional monitoring wells was not discussed in the work plan nor were the proposed well locations found in Figure 4-8 or Plate 1. What is the Navy's current position with regard to the advancement of this additional groundwater monitoring well?

The work plan has been revised to indicate the installation of three wells (one upgradient and two downgradient) at the pistol range.

29. **Page 72, Section 4.2.3.1, Paragraph 4**

The second sentence states that surface water samples will be taken when the lake is drained. General practice for taking sediment and surface water at the same location dictates that the samples be taken concurrently. The surface water sample is taken first, followed immediately by the sediment sample. This would indicate the need to take these surface water samples and the above-mentioned sediment samples prior to draining of the lake.

Please refer to our response to comment 21 regarding sampling at North Lake.

APPENDIX A
FIELD SAMPLING PLAN
ATLANTIC STANDARD OPERATING PROCEDURES

30. **Procedure No. 1022, Page 8 of 11, Section 6.4.2 — Sediment Samples**

This SOP indicates that a stainless steel spoon is to be used for collection of sediment samples. There are two concerns raised by this approach.

In order to avoid losing the surface layer of sediment while the sample is being raised through the overlying water and to obtain the appropriate sediment depth, a hand corer should be used.

This SOP has been revised to indicate that when sediment samples are submerged, they will be collected with a core sampler provided with a core catcher.

31. <u>**Procedure No. 1023, Page 6 of 8, Section 6.3**</u>

The text states that either dedicated Teflon bailers or peristaltic pumps may be used for groundwater sampling. The procedure needs to be revised to show that peristaltic pumps must not be used to sample VOCs in water samples.

This SOP has been previously revised to indicate that groundwater samples for VOC analysis will be collected with a bailer. Site-specific modifications to all of Atlantic's SOPs are presented in a table at the front of Appendix A to the Field Sampling Plan.

32. <u>**Procedure No. 1256-D**</u>

The SOP primarily discusses the sampling aspect and not the analytical requirements of Method TO-1. Appendix A does reference a "Technical Procedure" for Method TO-1, *Determination of Volatile Compounds in Ambient Air Using Tenax Adsorption and Gas Chromatography/Mass Spectrometry (GC/MS)*, however it is not included in the Appendix. Following are a list of items pertaining to Method TO-1 that must be addressed in the analytical and sampling SOPs.

This SOP was only intended to address sampling procedures. An analytical laboratory has not been selected at this time, therefore, it would be difficult to provide a laboratory SOP. To address this concern, a new section regarding laboratory analysis will be added to this SOP and Method T01 will be included as a part of Appendix A. This section will reference the analytical Method (T01) and add a provision that when a laboratory is selected, its SOP for T01 analysis will be submitted to EPA for review and approval.

- The SOP fails to include a target analyte list and quantitation limits for this site. Also, the maximum sampling flow rate must be established according to the procedures outlined in Section 7.1, *Flow Rate and Total Volume Selection* of Atlantic procedure No. 1256-D.

  A target analyte list is included. The laboratory SOP to be provided later will include quantitation limits. The laboratory will provide the Tenax cartridges, therefore, these computations cannot be made until the cartridge weight is known. The SOP details the calculations that will be used to determine the maximum flow rate.

- The SOP must delineate the analytical method to be used.

The analytical method will be Method T01. This has been specified in the new section in the SOP regarding analysis.

- What calibration process will be utilized? There are three potential calibration procedures 1) direct syringe injection of dilute vapor phase standards, 2) injection of dilute vapor phase standards into a carrier gas stream directed through the Tenax cartridge, and 3) introduction of permeation or diffusion tube standards onto a Tenax cartridge. These standardization techniques are explained in detail in method TO-1, Sections 13.1, 13.2 and 13.3.

  This will be addressed in the laboratory analytical SOP which will be submitted at a later date.

- Discuss the mechanism for the preparation and conditioning of the Tenax cartridges. Specify if the laboratory or Atlantic Environmental will be supplying pre-conditioned cartridges with a minimum of one sample per batch verified clean by GC/MS analysis.

  The laboratory will supply the cartridges. These cartridges will be verified clean by testing one sample per batch by GC/MS analysis.

- Specify if the internal standard (IS) or the external standard method of quantitation will be utilized. If the IS method is to be used, specify what IS(s) will be used and what the acceptance criteria for the IS(s) will be. Also, specify how the internal standards will be introduced onto the Tenax adsorbent.

  This will be addressed in the laboratory analytical SOP which will be submitted at a later date.

- Specify if surrogates will be introduced onto the Tenax prior to shipment to the field. These procedures must be described in detail and include acceptance criteria and corrective actions.

  This will be addressed in the laboratory analytical SOP which will be submitted at a later date.

- The constituency of the sampling lines used to collect the air samples must be provided. Tygon tubing must not be used upstream of the sampling train. Therefore, to eliminate potential analytical interferences, Teflon or stainless steel tubing is required.

  We agree and the SOP has been revised to specify only Teflon or stainless steel tubing.

- Page 4, Section 7.1.1 — Approximate breakthrough volumes should be provided in Table 1.

  The breakthrough volumes will be added to Table 1.

- Page 10, Section 8.3 — Backup cartridges should be used for each sample taken at this site. If the level of target analytes in the backup section exceeds 20 percent of the level of target analytes in the front half, resampling at a lower flow rate is required.

  Backup cartridges are specified for each sampling event. At a minimum, a backup cartridge for each ten sampling stations will be provided.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) AND DATA MANAGEMENT PLAN

33. The QA/QC Plan lists several possible methods to be used when analyzing surface waters or sediments for the CLP TCL and TAL. The Final Plan should list the specific methods to be utilized for each medium and analysis. When selecting analytical methods for surface waters and sediments, it is important for ecological risk assessment purposes, to obtain practical quanitation limits (PQLs) that are below any biological effects levels. Please check with the following two references with respect to determining these limits.

    - U.S. Environmental Protection Agency, Ambient Water Quality Criteria, 1986, Freshwater Chronic Criteria.

    - National Oceanic and Atmospheric Administration, *The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program*, NOAA Technical memorandum NOS OMA 52, August 1991.

    Specific methods are specified in Section 5.1 of the QA/QC Plan. These methods are presented in Tables 8-1, 8-2 and 9-1 of the Laboratory Quality Assurance Project Manual (Appendix A of QA/QC Plan) and for VOC analysis in Table 5-5 of the QA/QC Plan.

    Your comment regarding quantitation limits versus biological effects levels brings up an important issue. As we discussed, it is proposed to use CLP methods and we will obtain the lowest quantitation limits possible with these procedures. It is acknowledged, however, that some effects levels (e.g., chronic AWQC for DDT and mercury) are much lower than can be achieved with CLP methods. This issue is most important when performing the ecological risk assessment. Any limitations of the analytical methods will be discussed in the uncertainty section of the ecological risk assessment. Both contract required and method detection limits will be evaluated. Section 5.1.1 of the QA/QC plan has been revised to address this issue.

34. <u>Page 9, Table 3-1</u>

    The table shows that rinsate samples will be collected at a frequency of one per day. The table needs to be corrected to show that rinsate samples will be collected at a frequency of one per piece of equipment per matrix per parameter per day.

    Note 4 in Table 3-1 states that one equipment rinsate sample per day means one per day per matrix per piece of equipment for non-dedicated equipment.

35. **<u>Page 27, Section 9.1, Paragraph 5</u>**

The data package should be provided as an Appendix to the RI report.

Complete data packages will be provided to EPA. Due to the size of these data packages (several thousand pages), it is not practical to include them as an appendix to the report.

OTHER COMMENTS DISCUSSED

During the phone conference, the Navy's responses to U.S. EPA comments (April 15, 1993) regarding the CBU and OBDANE sections of the Work Plan were also discussed. The Navy's original responses are provided in this document. The issues discussed along with resolutions are presented below.

<u>General Comment 1.)</u>

The U.S. EPA indicated that the response appears acceptable, however, they would like to completely evaluate the QA/QC Plan as it relates to the CBU and OBDANE sites prior to giving their final concurrence.

<u>Specific Comment 11.), Second Paragraph</u>

The U.S. EPA indicated that this response was acceptable regarding the CBU and OBDANE sites, however, they would like us to re-evaluate the depth of borings selected at all other Phase II RI sites. In general, the U.S. EPA indicated that drilling to a depth of four feet below any evidence of contamination was only acceptable if some type of thermally enhanced headspace analysis for VOC was used in the field.

The Navy indicated that they would further evaluate this issue. Presented below by site for all sites except CBU and OBDANE is a table showing proposed boring depth and type of field screening proposed.

SITE	BORING DEPTH	FIELD SCREENING
Rubble Fill at Bunker A-86	Refusal	OVA
Torpedo Shops	Refusal	OVA
Goss Cove	Base of fill	OVA, XRF
Spent Acid and Disposal Area	15' and two borings to refusal	XRF
Area A Landfill	15' or water table	OVA, Field GC
Weapons Center	15', water table, or limit of contamination	OVA
DRMO	Base of fill	OVA, XRF
Lower Subase	Base of fill and two borings to refusal	XRF

The Navy agrees that all borings should be advanced below any evidence of contamination and that this decision should be based on the results of reliable field screening. As a result, the Work Plan has been revised to add an additional criteria that all borings will be advanced to a depth at least four feet below any evidence of contamination. After re-evaluating the field screening methods proposed, the Work Plan was revised to indicate a thermally enhanced OVA method will be used at the Weapons Center. All other sites either complete borings to refusal or already use an accurate and more appropriate field screening technique (based on type of contamination present) such as XRF or field GC techniques.

<u>Specific Comment 13</u>

The Navy agrees to analyze this sample for pesticides in addition to the other parameters proposed (i.e., TCL, VOC and SVOC, and TAL constituents).

NAVY RESPONSE TO EPA COMMENTS (JANUARY 8, 1993) ON DRAFT PHASE II REMEDIAL INVESTIGATION WORK PLAN (NOVEMBER 1992)

PROPOSED WORK PLAN
GENERAL COMMENTS

1. The text frequently refers to "to be considered (TBC) values". Revise the work plan to include an explanation of this acronym and a description how these proposed values will be used to evaluate the data generated from the investigation.

   TBC is an acronym for "to be considered." TBCs are non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs. The most significant TBC regarding this project are CTDEP's soil cleanup guidance values. TBCs will be used primarily as a screening tool to identify potential areas of concern. In addition, TBCs will be considered along with ARARs and the risk assessment in determining remedial action objectives. The work plan text will be revised to include the above discussion regarding TBC.

2. The draft work plan does not adequately define the analytical methods. Examples of the lack of specificity include:

   - "the samples will be analyzed by NET methods"
   - two methods are listed for determining the total organic carbon (TOC) content of the soils
   - incomplete description of the methods to be used for the Toxicity Characteristic Leaching Procedure (TCLP) (the work plan lists Method 1311, yet this is only a preparatory method)

   Revise the work plan to include all of the site-specific analytical methods and the quantitation limits for all of the proposed methods.

   Site-specific analytical methods will be highlighted in the tables provided in the laboratory QA/QC plan, and text will be checked to ensure consistency.

3. The Quality Assurance/Quality Control (QA/QC) Plan does not contain all the site-specific proposed methods or their respective quantitation limits (e.g., dioxins and radiologicals).

   Revise the work plan to include all of the site-specific analytical methods and the quantitation limits for all of the proposed methods.

Site-specific methods and their quantitation limits for dioxins and radiological parameters will be clarified in the text.

4. The QA/QC Plan does not clearly indicate that sediment samples must contain greater than 30 percent solids in order for the samples to be considered valid. Revise the work plan accordingly.

   The work plan will be revised accordingly.

5. The proposed work plan does not present a discussion of the data reporting/data submission procedures. Revise the work plan to include the data reporting procedures. This description should include the format in which the results will be presented and the presentation of the field screening data.

   Attachment 1 to these comments are proposed data reporting sheets. The summary tables will be presented in the body of the report and the comprehensive data reports will be included in the appendix.

   Regarding field screening, qualitative results such as those from the photoionization detector will be shown in boring or sample logs. Quantitative results (XRF and GC) and soil gas data will be summarized in the body of the report with complete results tabulated in an appendix.

   Complete data packages for any analytical results will be available upon request of a reviewer. For CLP parameters, the data packages will be adequate to allow EPA Level IV data validation.

6. Based on the information presented in the draft work plan, air pathway analyses for pollutants, in addition to VOCs, are required. EPA suggests that the U.S. Navy revise the work plan to include, at a minimum, the monitoring of the air pathways for lead, polychlorinated biphenyls (PCBs), DDT, and other semi-volatiles.

   The U.S. Navy should develop and air monitoring plan for the site investigation. For reference, the U.S. Navy should review the four volume Air/Superfund National Technical Guidance Study (NTGS) Series, as well as the attached Air Sampling Plan guidance (see Attachment A).

   The inhalation pathway has been evaluated for all of these constituents in the risk assessment conducted during the Phase I RI. In the human health risk assessment, we addressed the inhalation pathway for exposure to fugitive dust for all appropriate receptors. Based upon surficial soil data and PM10 information, the exposure point concentrations for dust were calculated. Conservative exposure assumptions were used in the calculation of risk to receptors at the site. Even under these conservative conditions, all of the carcinogenic risks and non carcinogenic hazard indices calculated for receptor exposure to site contaminants found in dust resulted in de minimus health risks. However, as we discussed, air monitoring for these constituents during any remediation activities, *as part of a health and safety plan, may be warranted and will be considered at that time.*

<u>EPA's Comment on Navy Response</u>

A review of the Navy's response to the need to conduct routine air monitoring, and the statement by the Navy of *de minimus* risk associated with inhalation pathway exposure via fugitive dust, EPA agrees that at this time, routine monitoring of air exposure is not required. However, during invasive remedial activities, additional monitoring of the inhalation pathway exposure, via fugitive dust, may be required.

The Navy states that a Standard Operating Procedure (SOP) for air sampling will be provided, however, this has not yet been submitted for review. It has been EPA's experience that the submitted SOP's are often deficient. Therefore, the Navy should consider submitting, and receive approval for, an air monitoring SOP prior to the initiation of sampling activities.

7. The draft work plan includes only brief references to the previously detected contamination, resulting in inadequate justification to support the proposed sampling locations. Additional figures which depict the extent of contamination are necessary to support the proposed sampling plan.

Provide maps which show the aerial and vertical extent of contamination which has been previously detected at the Step II Sites.

This information is provided in the Phase I RI Report. Rationale for sample selection based on Phase I RI results are indicated in Section 7.0 of the work plan. This comment and several subsequent comments either request detailed data previously presented in the Phase I RI Report be repeated in this work plan (e.g., present all previous data) or request presentation in the work plan of items that will be produced from implementation of the work plan (e.g., provide a bedrock contour map). If the Phase I RI Report had not been prepared, we agree that all available data should be presented in the work plan. However, we have summarized the findings of the Phase I RI Report in this work plan and have referred to the Phase I RI Report for details. Listed below is a summary of comments in these categories.

- *<u>General Comment 12</u>: Provide ground water elevation maps.*
- *<u>General Comment 13</u>: Provide a discussion of release mechanisms.*
- *<u>General Comment 21</u>: Include specific values for the exceedance of the ARAR/TBC values.*
- *<u>General Comment 23</u>: Include a discussion of the restrictions imposed by each location-specific ARAR.*

- ***Specific Comment 3**: Include a summary tabulation and data interpretation narrative of previous analytical results.*

- ***Specific Comment 63**: Provide maps showing ground water elevation, bedrock elevation and extent of contamination.*

Phase I information was summarized in the work plan. It could be repeated in the work plans, however, its inclusion provides no constructive use as it is readily available in the Phase I report. More importantly, providing any of the requested information that is out of the scope of the existing contract will delay the start of field work due to contractual requirements. In the responses that follow, we have indicated when the requested information is provided in the Phase I RI Report or where we feel it is a product of this work plan.

EPA's Comment on Navy Response

Modify the tables in Section 7.0 to include a column of "Data Gaps" which will provide additional support for the various sampling efforts.

8. Modify the work plan to include descriptions of the Supplemental Step I investigations. Provide the rationale for not including the investigative plans for the CBU Drum Storage Area or the OBDANE in this work plan.

   The investigation work plans for these two sites are presently being prepared. It is our intention to include these in the final work plan. The work plan for these sites will be submitted for review when completed. They were not included in this version of the work plan as a contract modification could not be completed in time to allow their inclusion.

9. Several references to inorganic background concentration levels are made throughout the work plan. These references include discussions of nature and extent (e.g., page 18, ¶4, page 35, ¶1, page 38, ¶2, etc.) and risk (e.g., page 70, ¶5) without recognizing the fact that these levels have not been approved by EPA.

   Qualify the references to inorganic background concentration levels with a statement which indicates that these levels have not yet been finalized.

   All references to background will be qualified as suggested.

10. There are numerous references throughout the work plan to contamination present at a particular unit which may "possibly be associated" with some other adjacent unit, or that "ground water flow is projected to be generally to the southwest (page 29, ¶1)" but there are no maps which portray the surface or subsurface flow relationships.

    EPA suggests that the U.S. Navy consolidate the investigation of the Rubble Fill at Bunker A-86, the Area A Landfill, CBU Drum Storage Area, Area A Wetland, Area A Downstream, Weapons Center, Over Bank Disposal Area, and the Torpedo Shops to help optimize the sampling activities outside of the immediate source areas.

We agree that sampling activities at all sites should be optimized by evaluating these sites in relationship to each other. Plate 1 (Field Sampling Plan - Area A) was prepared for this purpose. This plate shows all existing and proposed sample locations and the ground water flow direction. We do not agree, however, that consolidating the investigation and changing the designation of operable units are appropriate at this time. The current site designations allow the work plan to address the perceived risk and contaminants at each site, which are different, in an organized manner.

11. Revise the work plan to include the installation of additional ground water monitoring wells immediately upgradient of the Downstream Watercourse located along Triton Road. These shallow ground water monitoring wells shall be installed between the Pistol Range and the downstream watercourse. In addition, modify the work plan to include the collection of both upgradient and downgradient surface water samples from both of these drainpipes. These samples should be analyzed for metals; in particular lead. These ground water and surface water samples will identify potential releases of hazardous constituents from upgradient sources.

    Evaluation at the Pistol Range under CERCLA is presently under negotiation as part of the FAA between EPA, CTDEP, and the Navy. The Navy will comply with the final FAA.

12. Present ground water elevation maps (i.e., contouring of the potentiometric surface) with the interpreted direction of ground water flow for all Step II sites.

    These are provided in the Phase I RI Report and the interpreted direction of ground water flow is indicated in the work plan.

13. Modify the Site Dynamics section of the work plan to include discussions of the source areas and release mechanisms. The conceptual model approach should follow RI/FS guidance.

    As we discussed during our phone conference, Section 3.0 does include a conceptual site model, a summary of contaminants detected (which includes source areas) and an evaluation of potential migration pathways of chemicals in the environment. Minor revisions will be made to the text to clarify source areas. Potential receptors are identified in Sections 4.0 and 5.0 regarding human health and ecological risk assessment. Release mechanisms were presented in Section 5.0 of the Phase I RI Report and have been summarized in the work plan.

14. Without a basewide understanding of the bedrock elevation contours, it is not possible to fully understand potential migration pathways.

    Modify the work plan to include the development of a basewide bedrock elevation map. This modification should also include the use of seismic refraction surveys to obtain the bedrock elevation data where there are no borings.

The work plan will be revised to include development of a base-wide bedrock elevation map. Elevations to construct this map will be from existing and proposed borings/wells, bedrock outcrops, and available borings from Navy files. As this database will provide a large number of data points, we are not proposing seismic refraction surveys. We will have enough bedrock elevations to adequately construct a bedrock contour map.

15. Modify the work plan to clearly explain the procedures used to determine the potential target remediation levels, as presented in Section 6.0 and Appendix C. The work plan should also cite the appropriate guidance (e.g., Human Health Evaluation Manual, Part B: "Development of Risk-Based Preliminary Remediation Goals". OSWER Directive 9285.7-01B. December 13, 1991).

    Present, if applicable, sample calculations showing exposure assumptions used to develop each target remediation level need to be presented. For target levels based on ARARs rather than on risk assessment, provide the appropriate references for the use of the target level.

    Appendix C will be modified to include more detail regarding the derivation of risk-based remediation levels and a table will be included in this section which provides chemical-specific ARAR values.

16. The proposed work plan makes general references to numerous locations regarding analytical parameters. Modify the work plan to reference the U.S. EPA Contract Laboratory Program (CLP) Target Analyte List (TAL) and Target Compound List (TCL) whenever appropriate).

    The work plan text will be clarified to make it clear that constituents being tested are from the CLP, TAL and TCL whenever appropriate. This clarification, for example, will make it understood that when we specify VOC, we mean all VOC listed in the CLP TCL.

17. Modify the work plan to ensure that the ecological risk assessment includes the analysis of full TAL and TCL Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), pesticides and PCBs for all surface water and sediment samples, as well as Total Organic Carbon (TOC) and grain size analyses in sediments. Fresh water samples also require the analysis of hardness.

    We have excluded several CLP parameters from the scope of this work plan based on an evaluation of Phase I results. As the Phase I database is fairly extensive, we feel the exclusion of these parameters from further testing is justified. Approximately 32 sediment samples were collected during Phase I in Area A and analyzed for all CLP parameters and an ecological risk assessment was performed. Based on this extensive sampling and the risk assessment, the only concerns identified with sediments was regarding DDTR concentrations. The purpose of the Phase II work is to define the extent of this contamination and the risk it presents; not to determine if Area A may be contaminated with other hazardous constituents. The work plan will be revised to include analysis for TOC and grain size in all sediment samples. The work plan presently requires analysis of *hardness; however, the text will be clarified regarding this analysis.*

EPA's Comment on Navy Response

It is agreed that sampling in the Area A Wetlands has been extensive, and the full TAL/TCL analysis is not necessary. Since previous sampling efforts in the Area A Downstream/OBDA have been sparse, additional sampling requires the full TAL/TCL analysis.

Therefore, modify the work plan to include, at a minimum, full TAL and TCL analysis at proposed sampling locations 2DSD24, 2DSD25, and 2DSD27.

In the OBDA area, previous analytical results, specifically at sampling location 3SD4, showed elevated levels of arsenic (39.9 ppm), cadmium (30.1 ppm), copper (105 ppm), lead (189 ppm), selenium (3.2 ppm), and zinc (416 ppm). Elevated levels of PAHs were also noted. This would indicate that proposed additional samples would require the analysis of the full TAL and TCL.

In order to confirm the extent of contamination, revise the work plan to include full TAL and TCL analysis for additional samples taken at five additional locations 2DSD24 through 2DSD29.

18. EPA suggests that the U.S. Navy consider the Connecticut Arboretum across the Thames River in New London as one of the possible sources of surface water, soil and sediment background data. Although this area is separated from the base by the river, it is possible that it may resemble background conditions of the area.

The Navy did consider use of the Connecticut Arboretum as a background sample location. However, we decided that sediment and surface water should be collected upstream for background determination. Regarding soil samples, it was decided that these samples should be collected on the base or as close to the base as possible in similar soils. Based upon TRC comments, proposed background soil sample locations have been revised to move three sample locations offsite as shown in Attachment 2.

EPA's Comment on Navy Response

The Navy has decided that sediment and surface water samples will be collected upstream for background determination. In order to evaluate the entire sampling plan, it is essential to know the specific proposed locations for background samples for surface water and sediment.

On page 101 of the work plan, the Navy stated that prior to initiating the quantitative benthic survey, approval for the reference locations will be sought from BTAG. These locations have not been approved by the BTAG to this date.

In order to avoid any delays with the proposed field work, the approval process should be initiated shortly. Identify the specific reference locations to be used for the quantitative benthic survey and incorporate these into the work plan to avoid any delays at a later date.

19. The Remedial Action Objectives (RAOs) in the work plan do not adequately describe the contaminants of concern for ground water, the remediation levels and the remedial technology data requirements. Each remedial technology must have a corresponding list of data requirements specific to the technology.

    In addition, the draft work plan does not clearly describe whether the remedial investigation objectives tables fulfill the information requirements of the preliminary action objectives tables.

    Modify the work plan to ensure that each remedial technology has a corresponding list of data requirements specific to the technology and present the RAOs in the format specified in the Guidance for Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988). The modified RAOs should include the following components:

    - contaminant(s) of concern
    - exposure route(s) and receptors
    - acceptable contaminant level or range of levels for each exposure route

    The identification of the specific compounds and the preliminary remediation levels are needed to identify which technologies actually apply and to determine which contaminants require further delineation.

    There are several issues brought up in this comment. To address a few of these issues, the following modifications will be made to the work plan.

    - *A table providing chemical-specific ARARs will be added to the work plan.*

    - *A table containing remedial technology data requirements which will include rationale regarding parameters selected on a site-specific basis will be included in the work plan.*

    RAO regarding ground water at a few sites (DRMO, Goss Cove and Lower Subase) were not presented as the Navy does not feel it is an objective to remediate these areas to provide potable water and as the contaminant levels do not appear to be having an adverse impact on water quality in the Thames River. As stated previously, ground water is not a potential source of drinking water at DRMO, Goss Cove and Lower Base due to salt water intrusion. However, as the effects on the Thames River have not been verified, the remedial action objectives will be revised to include ground water remediation as necessary to protect water quality.

20. The investigative objectives of the work plan indicate that the selection of screen settings in the shallow and deep wells will be determined by the stratigraphic data gathered from the test borings. The screen placement should also consider the different physical

characteristics and mobilities of the contaminants at each unit.

For sites which are lacking information regarding the nature of the contaminants, such as the Rubble Fill at Bunker A-86, the work plan should consider the installation of well clusters, screened at various depths.

Modify the work plan to consider the physical characteristics and mobilities of the contaminants at each unit during the placement of the well screens and the installation of well clusters screened at various depths to help characterize inadequately defined areas.

The text will be revised to clarify that screen placement did consider the different physical characteristics and mobilities of the contaminants at each unit.

The work plan will be revised to include the installation of one bedrock well at Bunker A-86. If ground water is present in the overburden at the location of the bedrock well, a nested well will be installed in the overburden.

21. Modify the work plan to include the specific values (e.g., maximum values, average values, etc.) for the exceedance of the ARAR/TBC values, etc.) for the exceedance of the ARAR/TBC values in Tables 6-2, 6-4, 6-7, 6-9 and 6-11.

    This data is presented in the Phase I RI Report; however, we will provide a table showing chemical-specific ARARs in this report.

22. The sampling for engineering properties must be reviewed on a site-specific basis. The present work plan proposes the same set of analyses at each site, yet certain analyses may not be necessary at all sites.

    Modify the work plan to ensure that the sampling for the engineering properties will correspond to each specific area and the specific technologies which will be evaluated during the Feasibility Study at each specific site.

    A table containing remedial technology data requirements will be provided. This table will be site-specific and include rationale regarding selection of specific parameters.

23. The location-specific ARAR restrictions must be identified in order to evaluate whether certain actions may not be implementable. The various remedial alternatives must consider such items as vehicular and equipment access, staging areas, need for temporary roads or sewers, etc.

    Modify the work plan to include a discussion of the restrictions imposed by each location-specific ARAR. Include in the work plan modification a map which illustrates where each restriction applies. This information should be integrated into the preliminary remedial alternatives identification process.

This discussion regarding location-specific ARARs is provided in the Phase I RI Report.

24. The following are general comments regarding the attached memo on target soil cleanup levels, prepared by Menzie-Cura and Associates, Inc. addressed to Barry Giroux (March 9, 1992).

- Provide the rationale for the proposed cleanup levels based on a worker scenario rather than a residential scenario? The proposed cleanup levels based on a worker scenario are often orders of magnitude greater than a residential scenario. These levels can not adequately protect the general public.

- Most of the proposed cleanup levels are based on target cleanup levels of 10^{-4}. EPA requires each chemical use 10^{-6} as the target risk level such that total risk from all the chemical mixtures will fall within the acceptable risk range of 10^{-4} to 10^{-6}. Modify the work plan accordingly.

- Since no equations and calculations are presented along with the memo, it is unknown if the cleanup levels are accurately derived. Revise the work plan to include the equations and assumptions used in the development of the proposed cleanup levels.

Appendix C will be modified to provide the requested information.

25. Revise the work plan to ensure that Standard Operating Procedures (SOPs) are prepared for all aspects of sampling, analysis and instrument calibration. An SOP is defined as a complete description of a sample collection, analysis or other operation whose mechanisms are thoroughly prescribed and which details a commonly accepted method of performing routine or repetitive tasks. See Attachment B for additional information regarding the development of these SOPs.

SOPs will be prepared for the following activities:

- *field analysis for PCB and DDTR using GC methods*
- *field analyses for lead using XRF methods*
- *air sampling for VOCs using EPA Method TO1*

SPECIFIC COMMENTS

1. **Section 1.0 - Introduction (Page 1)**

The purpose and scope of the Phase II Remedial Investigation are not stated in the text. The narrative of the Draft Work Plan should begin with a clearly defined "Purpose and Scope" of the proposed RI.

Modify the work plan to include a purpose and scope which reflects the objectives of this investigation.

A purpose and scope section will be added to the work plan.

2. **Section 1.0 - Introduction (Page 4)**

Modify this figure to include the location of the former incinerator, Pier 33, Berth 16/Former Incinerator, the fuel farm, and the Area "A" Downstream zone of investigation. Include in the work plan modification a brief discussion of the known and suspected contamination at these sites.

The figure will be included to show the location of the Former Incinerator/Berth 16, Pier 33 sites and Area A downstream. The fuel farm is not part of the RI at this site, and therefore will not be shown. Information regarding contamination at this site will consist of a reference to the appropriate report.

EPA's Comment on Navy Response

Modify the work plan to include a map of all potential source areas. Since many of the non-IRP sites are located upgradient or adjacent to sites being investigated under the IRP, it is important to identify the location of other potential sources of contamination. Sufficient sampling locations should be positioned to separate ground water and surface water contamination from adjacent sites.

3. **Section 2.0 - Evaluation of Existing Data (Page 8)**

Modify the work plan to include a summary tabulation and data interpretation narrative of the site-specific analytical results of the previous investigations. The work plan should summarize the site-specific geological and chemical contaminant conditions.

This information is provided in the Phase I RI Report. A summary of contaminants detected and site-specific geology was provided in the work plan.

4. *No EPA comment provided.*

5. **<u>Section 2.3.1.2 - Site-Specific Geology and Hydrology (Rubble Fill at Bunker A-86) (Page 18, ¶3)</u>**

This section describes local ground water flow to the northwest. Modify the work plan to include a local ground water map, with the potentiometric surface contours and flow directions, which reflects the ground water flow directions discussed in the text.

Figure 2-8 shows the inferred ground water flow direction. No data is available to prepare a ground water contour map at this location.

6. **<u>Section 2.3.1.3 - Nature and Extent of Contamination (Rubble Fill at Bunker A-86) (Page 18, ¶4)</u>**

EPA has previously questioned the source of the "To Be Considered" (TBC) values listed in the previous report (i.e., Table 4-2: Summary of Chemical-Specific ARARs and TBCs by Media in Draft RI, August 1992). In particular, EPA was concerned with the soil TBC values which listed exactly the same values as drinking water ARARs and the source is listed as CTDEP. The values of TBCs in soil are risk-based concentrations (i.e., based on risk level or hazard index).

For the purpose of this investigation, the concentration of the chemicals in the soil is obtained through the Contract Laboratory Program (CLP) chemical analysis for solid waste; not the product of the TCLP. Therefore, the results of this method cannot be compared to RCRA regulatory levels and cannot be compared to the CTRL (which is based on and equal to drinking water standard) as is currently proposed for this site.

Modify the work plan to clearly define the "TBC" values in soil.

This issue has previously been discussed several times. Each time the Navy, EPA and CTDEP agreed that classification of the CTDEP guidelines regarding soil remediation as a TBC is appropriate.

7. **<u>Section 2.3.2.1 - Site Background (Torpedo Shops) (Page 19, ¶2)</u>**

EPA has not reviewed the 1989 GZA report, and therefore can not evaluate or support the conclusions which have been presented in this section. Based on the portion of the report included in Appendix A, it appears that samples were not collected in accordance with EPA protocol (e.g., samples consisted of auger cuttings and the analytical data was not validated).

Revise the work plan to include confirmatory sampling in accordance with EPA-approved methods and add dioxin to the list of analytes.

EPA and CTDEP will be provided with copies of the GZA report. Samples are proposed to be collected from 7MW5D and will be used to confirm the GZA results.

The Navy has not proposed sampling for dioxin at this site as no dibenzofuran were detected during the Phase I RI and chlorinated materials were not burned at this site. Further detail regarding this issue is presented in the responses to Comment 51 below.

8. <u>**Section 2.4.1.1 - Site Background (Page 33, ¶8)**</u>

This section references the collection and analysis of samples from the Weapons Center. EPA has not previously reviewed this data, and it is not clear what sampling protocols were used to obtain the samples.

Modify the work plan to provide a full discussion of the Appendix B sample results, include a map of the sample locations and describe the sample locations denoted as "above table" and "below table" and "below grade".

The work plan will be revised to include all available information regarding collection of these samples. As the purpose of this sampling was to determine whether structurally unsuitable soils removed during a construction project were contaminated, any available information is limited.

9. <u>**Section 2.4.1.1 - Site Background (Page 33, ¶1)**</u>

Modify the work plan to remove the reference to "published background levels" since these "background" levels are not relevant to this investigation.

The reference to background levels will be removed.

10. <u>**Section 2.4.1.3 - Residential Well Analytical Results (Page 42, ¶5,6)**</u>

Revise the work plan to incorporate the newly promulgated MCL for cadmium at 5 ppb. (Federal Register, January 1991) and reevaluate the concentration of this metal in relation to this standard.

Revise the work plan to reflect the regulatory status of sodium. Sodium does not have a secondary MCL, but the Office of Water of the EPA has set a drinking water equivalent level (DWEL) of 20 mg/L as guidance for persons who have hypertension problems.

Phase I data will be re-evaluated in light of the new MCL for cadmium. The table of chemical-specific ARARs in the work plan will include this new value.

This table (chemical-specific ARARs) will include the EPA DWEL of 20 mg/l and the CTDOHS notification level of 28 mg/l for sodium.

11. <u>**Section 2.4.1.3 - Residential Well Analytical Results (Page 43, ¶1)**</u>

Revise the work plan to include a discussion of the analytical uncertainty associated with the existing boron data.

This revision will be made.

12. <u>Section 2.4.3.3 - Nature and Extent of Contamination (Page 51, ¶6)</u>

This section references the discovery of thin layers of free product in MH83.

Present the location of MH83 on Figure 2-15.

Manhole MH-83 will be shown in Figure 2-15.

13. <u>Section 3.2.1 - Rubble Fill at Bunker A-86 (Page 54)</u>

Modify this figure in the work plan to depict the possibility of direct contact between the fill and bedrock, since bedrock is exposed at the surface near this site.

This figure will be revised to show the potential for fill directly in contact with bedrock.

14. <u>Section 3.2.2 - Torpedo Shops (Page 56)</u>

Modify this figure in the work plan to include all source areas, including the Otto fuel tanks. The modification to this figure should also include a transport pathway to bedrock and pathway of discharge to surface water and sediment.

Modify this figure to provide an illustration of the location and depth of the tanks, drainage lines, leach fields, existing and proposed monitoring wells and borings, the bedrock geologic unit contact, previous sample locations which have been determined to be contaminated, and any other pertinent site features. These data are fundamental to the conceptual model.

Figure 3-2 will be modified to show source areas and the potential transport pathway to bedrock. The transport pathway to sediments and surface waters is shown.

Figure 7-4 will be revised to show drainage lines. It is not feasible to show the information in Paragraph 2 of this comment in a conceptual diagram.

15. <u>Section 3.2.3 - Goss Cove Landfill (Page 57)</u>

Modify this figure to include a ground water flow path into the bedrock where the fill is, or is suspected of, being in direct contact with bedrock.

We will revise this figure to better depict the bedrock surface. As this is a discharge area, bedrock contamination is only possible in the eastern portion of this site, and any such contamination will be localized and quickly discharged to the overburden. Deep overburden wells have been provided to detect any such contamination.

16. <u>**Section 3.3 - Supplemental Step II investigations (Page 60, ¶5)**</u>

Revise this work plan to reflect the fact that the proposed inorganic background levels have not yet been approved by EPA.

The work plan will be revised to reflect this fact.

17. <u>**Section 3.3 - Supplemental Step II Investigations (Page 61)**</u>

Modify this figure to include the CBU Drum Storage Area, the Torpedo Shops, and, if applicable, any offsite contamination.

The location of those sites will be added to this figure.

18. <u>**Section 4.1 - Introduction (Page 68, ¶6)**</u>

While carcinogenic risk can be explained in probability terms, non-carcinogenic risk should be described as a hazard index. Modify the work plan accordingly.

We will revise the text of the work plan as follows: "The risk assessment will provide estimates of potential risks to human health. Risks will be estimated for representative groups.... "

19. <u>**Section 4.2 - Data Evaluation and Hazard Identification (Page 70, ¶5)**</u>

Revise the work plan to explain the source of the background concentrations referenced in this paragraph and used to select compounds of potential concern.

This comment is directed towards paragraph 4, not 5.

We feel that it is premature to state the background concentrations at this point as they will be determined by additional sampling. However, we will revise the text of the work plan as follows: "Sampling is required for supplemental investigations at these Step II sites. The outcome of the sampling will dictate the final list of compounds of concern. Prior to implementation of this work plan, sampling and analysis to define inorganic concentrations in soils will be conducted. Background sampling is conducted to distinguish site-related contamination from naturally occurring or other non-site-related levels of compounds. In addition, compounds of concern will be selected for the Rubble Fill .... "

In addition: 4.2.1 Evaluation of the Quality of Available Data (Page 70, ¶1)

"The selection....... field blank concentrations (USEPA, 1992).

U.S. EPA, 1992. Guidance for Data Useability in Risk Assessment (Part A). Office of Emergency and Remedial response. 9285.7-09A.

20. **<u>Table 4-1 - Compounds of Concern for Step II Sites (Page 71)</u>**

Compounds of concern should be presented as medium-specific. It is illogical to evaluate risk or develop cleanup level if the threat posed by these various contaminants are unknown in each of the affected media.

Revise this table to clearly indicate the compounds of concern for each of the various media at this site.

We will present the compounds of concern as media specific in the work plan.

21. **<u>Section 4.2.3 - Selection of Compounds of Concern (Page 73, ¶3)</u>**

This section of the work plan is not clearly written. Revise the work plan to clearly define the frequency of detection and the spatial extent of contamination which is proposed to select compounds of potential concern. Include in this revision how the "natural range of elemental abundance" for each inorganic compound will be determined.

We will revise the text of the work plan as follows:

The compounds of potential concern are those judged to be important site-related contaminants with regard to potential human health risks. Selection of compounds of potential concern was made based on a review of available data and consideration of the following criteria:

- *Only compounds for which positive data (i.e., analytical results for which measurable concentrations are reported) were available in at least one sample from each medium were considered as compounds of concern for the site. If there were no positive data and information existed to indicate that the compound was present (e.g., fate and transport characteristics of the compound, or detection of the compound in other media) then that compound was included.*

- *The quantitation limit of a compound must have been less than corresponding standards, criteria, or concentrations derived from toxicity reference values.*

- *The presence of an inorganic compound was at concentrations above its natural range of elemental abundance (Shacklette and Boerngen, 1984).*

- *The spatial extent of contamination was considered by the evaluation of the selection of sampling locations, presence of potential hot spots and a sufficient number of samples collected over the time frame of the investigation.*

22. **<u>Section 4.3.2 - Identification of Potentially Exposed Populations (Page 74, ¶ 1 & 3)</u>**

Revise the work plan to include a statement that the identification of exposed populations and exposure routes under current and future land use conditions will be explained and justified in the Phase II Remedial Investigation risk assessment report.

We will revise the text of the work plan as follows: "The identification of exposed populations and exposure routes under current and future land conditions will be explained and justified in the Phase II Remedial Investigation risk assessment report. Future receptor at the sites include: workers......."

23. <u>**Table 4-2 - Exposure Summary for Potential Human Receptors (Page 75)**</u>

Since all the contact rates in the exposure equations in the risk assessment guidance are based on per day consumption (except for swimming scenario), revise this table to eliminate the column for exposure duration (i.e., time/event) with the unit hour/day except for the swimming scenario.

Provide the rationale for the lack of future receptors associated with the Torpedo Shops, although the text of paragraph 2 of page 74 states that potential future receptors at the Torpedo Shops include workers involved in excavation and construction activities.

Table 4-2 will be revised to reflect EPA's comments.

24. <u>**Section 4.3.4 - Estimation of Average Daily Doses (Page 80)**</u>

Revise the exposure equations of this section of the work plan to Exhibits 6-11, 6-12 through 6-18 of the Risk Assessment Guidance from Superfund (RAGs), Volume 1 Human Health Evaluation Manual (Part A) 1989.

Except for site-specific data, exposure parameters should be referenced in the following hierarchy: 1) Supplemental Guidance to RAGs: Standard Default Exposure Factors, 2) RAGs, 1989, 3) Dermal guidance, 4) Region 1's guidance, and 5) Exposure Handbook.

The exposure equations in this section of the work plan will be revised.

We will revise the text of the work plan to read:

"Exposure assumptions used in the calculation of average daily doses will be developed based on discussions with USEPA Region I personnel and guidance presented in: 1) Supplemental Guidance to Risk Assessment Guidance: Standard Default Exposure Factors (1991); 2) Risk Assessment Guidance (USEPA 1989); 3) Dermal Exposure Assessment: Principles and Applications (USEPA 1992); 4) Region I specific guidance; and 5) the Exposure Factors Handbook (USEPA 1989).

25. <u>**Section 4.4.1 - Toxicity Assessment for Non-Carcinogenic Effects (Page 82, ¶1)**</u>

Based on the document provided to EPA Region I by ECAO, entitled "Evaluate the appropriateness of using proposed surrogate RfDs (U.S. Naval Submarine Base, New

London/Groton, Connecticut), Part 1, 2 and 3", the statements in this paragraph are incorrect.

In Part II, Attachment 2 - "Feasibility of developing an RfD for Acenaphthylene by Analogy to potential Surrogates (Phenanthrene, Acenaphthene)", ECAO concluded that it is inappropriate to use the RfD from Phenanthrene or Acenaphthene for Acenaphthylene. In Part III, Attachment 1 - "Risk Assessment Issue Paper for Status of Polyaromatic Hydrocarbons", ECAO further updated the toxicity for all the PAHs. Neither attachment includes the statement of the first paragraph of page 82 of this work plan.

In addition, EPA Region I has previously advised Menzie-Cura & Associates, regarding the Region I interim policy to use the RfD of Naphthalene as the surrogate RfD for the non carcinogen PAHs which do not yet have verified RfDs.

Revise this section of the work plan to incorporate the use of the RfD of naphthalen as the surrogate RfD for the non-carcinogen PAHs which do not yet have verfied RfDs.

Although we do not agree with EPA, we will change the text of the work plan as follows:

As reference doses for phenanthrene and acenaphthylene are not available, following Region I guidance, the RfD for naphthalene will be used as a surrogate RfD for the noncarcinogenic PAHs which do not yet have verified RfDs.

26. <u>Section 4.4.1 - Toxicity Assessment for non-Carcinogenic Effects (Page 82, ¶4)</u>

The lead uptake/biokinetics model is developed for evaluation of lead exposure in children, and therefore should not be used for evaluation of adult population.

Revise the work plan to delete the reference to the use of the lead/uptake/biokinetics model for the adult population.

Although we discussed this point with EPA, we are not satisfied with the explanation. It is agreed that the most sensitive population to the adverse health effects of lead are children and that the IU/BK model was derived for evaluation of lead exposure in children, however, by adjusting the input parameters to reflect adult pharmacokinetics data, a similar approach can be used to evaluate lead exposures in adults. By eliminating this receptor group, a potential risk might go unnoticed. We will contact toxicologist Anne Marie Burke at Region 1 for discussion of this point.

<u>EPA's Comment on Navy Response</u>

If the Navy would like to submit, for EPA review, the proposed modifications to the IU/BK Model of lead in an adult, then this would be acceptable. At this time, however, the IU/BK Model cannot be modified to simulate lead exposures in adults and therefore, the use of this model should be limited to the section defining uncertainty.

In addition, it should be noted that children under the age of six years, rather than adults, are the subpopulation of concern due to the nature of the adverse health effects of very low blood lead levels for this age group.

27. <u>Section 4.4.1 - Toxicity Assessment for Non-Carcinogenic Effects (Page 83, ¶1)</u>

Revise the work plan to cite the Dermal Exposure Assessment Guidance for the dermal exposure pathway. Include in this revision the use of the absorption factors for a few chemicals in soil and the recommended permeability constants for surface water.

We will revise the text of the work plan as follows:

"...until further guidance is recommended. For dermal exposures from soils, the percentages of 2,3,7,8-tetrachlorodibenzo-p-dioxin, 3,3,4,4-tetrachlorobiphenyl and cadmium absorbed are 0.1-3%, 0.6-6%, and 0.1-1.0%, respectively (USEPA 1992). For the percentage of other compounds absorbed through the dermal route from soil, EPA Region 1 will be contacted. For estimating the dermally absorbed dose per event from water, the permeability coefficient from water through skin (cm/hr) can be obtained from Table 5-7 in the dermal guidance document (EPA, 1992). If there are no published values for specific compounds, the default value of 10^{-3} cm/hr will be used for an inorganic compound. For absorption of organics from water, the partition coefficient between octanol and water will be used as determined first, from Table 5-7 or second, from other databases".

NOTE: This paragraph should also be added to the dermal guidance for noncarcinogenic effects. (Page 82, ¶3).

<u>EPA's Comment on Navy Response</u>

EPA - Region I has previously recommended the use of the upper-bound of percent absorbed for polychlorinated compounds (e.g., 3% for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, 6% for all polychlorinated biphenyls and aroclors). Other compounds, such as TCCD, TCB and cadmium, should be assessed qualitatively in the uncertainty section.

28. <u>Section 4.4.1 - Toxicity Assessment for Non-Carcinogenic Effects (Page 83, ¶2)</u>

Revise the work plan to incorporate the oral cancer potency factor for benzo(a)pyrene. The standard is 7.3 per mg/kg/day (as opposed to 5.8 per mg/kg/day recommended earlier; the change is due to the detection of a mathematical error) which is currently on IRIS.

Since the relative toxicity equivalent factor approach has not been finalized by EPA, it should not be presented in this work plan. Revise the work plan to reflect the status of the toxicity factor and delete references to other regions' approaches to risk assessment.

The text of the work plan will be changed to include the current CPF for benzo(a)pyrene as follows:

"As per EPA Region I guidance, the EPA-derived cancer potency factor of 7.3 $(mg/kg/day)^{-1}$, or the most current CPF will be used as a surrogate for all polyaromatic hydrocarbon carcinogens until further guidance is recommended.".

We will be presenting the relative toxicity equivalent factor approach to provide a complete picture of potential risks due to exposures of receptors to carcinogenic PAHs. Since Region I is adamant about its inappropriateness, we would like to present this approach in the uncertainty section.

EPA's Comment on Navy Response

Although two sets of Toxicity Equivalent Factor (TEF) values have been listed in the 1991 Drinking Water Criteria for Polynuclear Aromatic Hydrocarbons (PAHs), the document does not recommend the use of the TEF approach before EPA has completed a critical review and analysis of the approach.

Furthermore, according to Part III, the Navy should evaluate the appropriateness of using the proposed surrogate RfDs issued by ECAO. More specifically, on page 3 of the risk assessment issues paper for the status of PAHs, ECAO also recommends that the use of the TEF approach at this time would be inappropriate. Thus, it is the interim policy of EPA - Headquarters, not Region I, which prohibits the acceptance of the TEF approach.

29. **Section 5.3.2.3 - Additional Terrestrial Field Assessments (Page 99, ¶3)**

In order to assess pesticide bioaccumulation, the draft work plan proposes to analyze the tissue concentrations of healthy earthworms after the 28-day bioassay is completed. It would appear that earthworms exhibiting sub-lethal effects (e.g., coiling, swelling) should also be analyzed for pesticide tissue concentrations as these individuals may represent worms most exposed to soil pesticide concentrations.

Revise the work plan to provide the rationale for not including these individuals in the tissue analyses.

Sterile silica sand does not appear to be optimal substrate for the earthworm. A combination of silica sand, peat and reagent grade lime may be a better choice of substrate.

Provide the rationale for use of sterile silica sand, or modify the work plan to include a different substrate.

The work plan will be revised to include analysis of earthworms exhibiting sub-lethal effects as well as healthy earthworms. The first sentence on page 99, paragraph 3 will be amended as follows:

Introduced Earthworm Bioaccumulation: After 28 days, the remaining living earthworms and approximately 0.5 kg of soil will be removed from the site chambers for five of the bioassay stations.

The substrate for the reference earthworm bioassays will be revised. The fourth sentence in paragraph 2 on page 99 will be amended as follows:

A reference chamber is also employed using an artificial soil composed of sterile silica sand (68%), kaolin clay (20%), peat moss (10%), and pulverized calcium carbonate (2%) as substrate (Callahan and Wilborn, 1988).

The reference is:

Callahan, C.A. and D.C. Wilborn, 1988. Earthworm Toxicity Test for Solid Waste and Superfund Sites, Health and Environmental Review Division, Office of Solid Wastes, Office of Hazardous Wastes/Superfund, Environmental Protection Agency, Washington, D.C.

30. **Section 5.3.2.4 - In-Field Earthworm Bioassays Using Sediment (Page 100, ¶2)**

The text proposes to use terrestrial (as opposed to aquatic) worms in bioassay chambers placed at the pond bank. There are several concerns with this approach:

- The method proposes to use terrestrial earthworms to assess the toxicity of an aquatic substrate.

- The sediments for the test will be relocated from within the pond to the pond bank, where the sediments are not truly *in-situ*.

Provide further justification for this approach, including references which describe previous studies where terrestrial earthworms have been used to assess aquatic sediment toxicity.

Clarify the methodology proposed for performing in-field bioassays, in particular, explain why standard ASTM laboratory sediment toxicity tests are not being performed.

Earthworms were chosen for the sediment bioassays to provide a cost effective survey in terms of time and equipment. The sediment bioassays can be performed at the same time using the same equipment as the terrestrial earthworm bioassays.

The earthworm bioassays are intended to provide an indication of the toxicity of the sediments to biological systems in general, not to a particular organism. Earthworms may be used as a surrogate organism in this manner because they are sensitive to the primary contaminant in the sediments, DDT isomers, and they are known to bioaccumulate it.

The sediment bioassays will occur concurrently with chemical analyses, terrestrial earthworm bioassays, and with sediment sampling for benthic organisms. Therefore, there will be a basis of comparison among contaminant concentrations, results of the soil and sediment bioassays, and the benthic analyses. The results of these different methods will provide a weight of evidence as to the toxicity of the sediments.

Lumbricus terrestris have been used for toxicity testing in a wide range of moisture conditions including total submersion. Mac et al. (1990) performed bioaccumulation assays with freshwater sediments using L. terrestris. They chose this organism as a surrogate for freshwater benthic organisms because of its size and its physiological similarity to aquatic organisms. The size is an important factor because larger organisms provide more mass for chemical analysis. Physiologically, earthworms need a moist environment for respiration and excretion functions which make them similar to aquatic organisms.

One of the problems with using earthworms for toxicity testing in media with greater than optimum moisture content is the depletion of oxygen during the test rather than the presence of excess moisture (Callahan, C.A., personal communication, 1993). Since the sediments to be tested are expected to be aerobic, this is unlikely to represent a problem during the test. Frequent observations will be made during the bioassay to ensure that the worms are burrowing into the sediment and that their exposure is more representative of organisms living in the medium. If the sediment is too moist or too rocky and the worms don't burrow into it, it will be mixed with a known amount of artificial soil.

Mac, M.J., Noguchi, G.E., Hesselberg, R.J., Edsall, C.D., Shoesmith, J.A. and J.D.Bowker, 1990. A bioaccumulation bioassay for freshwater sediments, Environmental Toxicology and Chemistry, Volume 9, pp. 1405-1414.

EPA's Comment on Navy Response

There is still some questions as to the validity of using earthworms for sediment bioaccumulation assays. The response cited the need for sufficient tissue mass for chemical analysis. While that need is recognized, it is questionable as to whether earthworms are appropriate surrogates for benthic invertebrates. It is felt that assessment of the benthic environment may better be served through the use of actual benthic inhabitants.

Since the required tissue mass for DDT analysis is only approximately 1 gram dry weight, other species more suited to the benthic environment may serve the purpose.

As an example, bioassays have been performed using Chironmus tentans larvae, placed in Nytex envelopes, submerged in the sediments for the duration of the test period. Sufficient numbers of larvae could produce the tissue mass required for analysis.

Although it is recommended that Lumbricus terrestris not be used, the following suggestions on its use are made based on a conversation with Clarence Callahan (EPA) on March 5, 1993.

Although L. terrestric may survive in a submerged situation, they will be stressed, and such a test will not reflect their normal metabolism. The organisms may actually accumulate additional contaminants due to absorbing and excreting large quantities of water.

The removal of sediments to the banks of the wetland cannot be correctly called an *in situ* test. This is not simply a problem of semantics. The sediments may compact and dry once out of the water, forming and impermeable mass that the earthworms cannot penetrate. This test could be performed better in a laboratory setting where better monitoring of the test could be done. In either setting, consideration should be given to mixing in 50/50 ratio of samples and reference sediment to prevent hardening of the sediment, depending upon the expected DDTR concentrations. In addition, it is suggested that the containers be opened at 24 hours, and every 7 days to ensure that the worms are in fact burrowing into the sediment.

Therefore, if *in situ* tests are to be performed, the test species used should be Chironomous tentans. However, if laboratory tests are performed, another species of Lumbricus should be used, not terrestris.

31. **Section 5.3.2.4 - Additional Assessment of Freshwater Systems in Area A (Page 100, ¶4)**

Revise the work plan to indicate that the species of frog collected will be recorded, and it is recommended that a potential year-round resident frog species (i.e., green frog, pickerel frog) be collected.

Page 100, ¶ 4 of the work plan will be revised to indicate the species of frog collected. The following sentences will be added to this section after the first sentence:

The species of frog will be recorded. The collection effort will focus on year-round resident species such as Green Frog. This species was observed in Area A during previous work at the site in April 1990.

What is now the second sentence in this section will begin a new paragraph.

32. **Section 5.3.2.4 - Additional Assessment of Freshwater Systems in Area A (Page 101, ¶5)**

A biotic index will provide additional insight into the relative health of the aquatic benthic communities. Revise the work plan to indicate that a biotic index (i.e., Hilsenhoff Biotic Index) will be determined for each of the benthic sampling stations.

The work plan will be revised to indicate that the Hilsenhoff Biotic Index will be used to assess the relative health of the aquatic communities. The following sentences will be *inserted after the second sentence in ¶ 5 on page 101:*

In addition, the Hilsenhoff Biotic Index will be calculated for each sampling station. Information will be obtained from the Connecticut DEP regarding the use of this index in Connecticut and tolerance values assigned to particular taxa in this geographic area.

33. <u>Section 5.3.3 - Wetlands Delineation (Page 102)</u>

In order to be in agreement with the Army Corps of Engineers, EPA requires the use of the 1987 version of the "Corps of Engineers Wetlands Delineation Manual", rather than the referenced 1989 version.

Revise the work plan to reference the 1987 version of the "Corps of Engineers Wetlands Delineation Manual".

The reference to the Federal Manual for Identifying and Delineating Jurisdictional Wetlands on page 102, paragraph 1 will be changed to 1987, rather than 1989.

34. <u>Table 5-2 - Thames River Field Sampling Plan (Page 105)</u>

The use of upgradient and downgradient sampling locations as comparison for the evaluation of NLON Submarine Base impact dictates that surface water at these locations be analyzed for pesticides also.

Revise the work plan to include the sampling of surface waters and include the analysis of pesticides to the analyte list for the upgradient station. This information is necessary to provide data on background concentrations that are not attributable to the subase.

Table 5-2 on page 105 will be revised to include the analysis of the two upriver (upgradient) water samples for pesticides.

35. <u>Section 5.3.4.4 - Caged Oyster Study (Page 108)</u>

Revise the work plan to include a detailed description of the preparation techniques for the VOC analysis, in particular, discuss the efforts to be taken to ensure that the volatile constituents will not be lost in the process leading to low recoveries and useless results.

In regards to the freezing of tissue for later analyses, according to the CLP protocols, the sample holding times will be a limiting factor. Revise the work plan to include an expanded discussion of the time required from the collection of the sample to the time of the analysis.

Revise the work plan to provide the rationale for the selection of oysters as the test species and not mussels.

Page 108, ¶3 under Section 5.3.4.4 will be revised. The fourth sentence of this *paragraph will be revised to read:*

At the end of the deployment period, the oysters will be shucked immediately and frozen. Samples will be delivered frozen to the analytical laboratory.

The following sentence will be added at the end of the paragraph:

Sampling holding times will conform to CLP protocols.

The tissue samples will be analyzed for VOCs by a modified Method 8240. In place of a purge and trap method, the tissue is first sonicated with a small amount of reagent water. The VOCs driven from the sample in this manner are then captured in a liquid nitrogen cold trap. From this point on, the analysis follows standard GC/MS methods. Sample handling is kept to a minimum with this method

The work plan will be revised to provide the rationale for using oysters rather than mussels as the test species. The following will be inserted on Page 108 after the first sentence of the third paragraph under Section 5.3.4.4:

Oysters will be used as test organisms rather than mussels (the organisms traditionally used in this type of test), because oysters are more tolerant of variations in salinity. There is a salinity gradient with depth in the Thames River near the subase and the use of oysters as test organisms will allow the cages to be placed in shallower, less saline water, if necessary.

36. <u>**Section 5.4.1 - Identification of Contaminants of Concern (Page 109)**</u>

The statement is made in the first paragraph that the contaminants of concern have been identified for Area A. This is incorrect; EPA's comments from the last review clearly indicated that there are some areas of disagreement in the contaminants of concern list.

Revise the work plan to either eliminate or qualify this statement accordingly.

This section gave the mistaken impression that the contaminants of concern have been chosen for the site. The second, third, and fourth sentences of Section 5.4.1 will be replaced with:

The previous investigation performed for Area A provides a preliminary list of contaminants of concern identified at the site. This list will be amended depending on the results of the analyses conducted under this work plan.

The first bullet in this section will be revised as follows:

- *Concentration in sediments, surface waters, and ground water that may discharge to the Thames River. Concentrations of contaminants in Area A surface soil, sediments, surface water, and ground water.*

37. **<u>Section 5.5.2.1 - Estimating Exposure in Soils and Sediments From Organic Contaminants - Equilibrium Partitioning (Page 112)</u>**

This is only discussion on the use of the Equilibrium Partitioning (EP) approach.

Revise the work plan to expand the discussion to include the evaluation of the inorganic contaminant exposure assessments.

A new section (Section 5.5.2.2) will be added on page 113 of the work plan to discuss exposure assessment to inorganic contaminants. The existing Section 5.5.2.2 will become Section 5.5.2.3.

Section 5.5.2.2 *<u>Estimating Exposure in Soils and Sediments from Inorganic Contaminants</u>*

Direct measurements of concentrations will be used to estimate exposures to inorganic contaminants in soil and sediments. These will be used on a location by location basis.

For Area A soils and sediments, inorganics with concentrations greater than background (as determined in a separate on-going study) will be treated as contaminants of concern. Soil concentrations will be compared to available information on phytotoxicity and soil invertebrate toxicity data on a location by location basis. Sediment concentrations will be compared with toxicity benchmarks developed by Long and Morgan (1990).

Exposure of benthic organisms to inorganic contaminants in Thames River sediments will be assessed via comparisons with upstream and downstream concentrations, literature concentrations for the Thames River estuary in particular and urban estuaries in general, and Long and Morgan data.

38. **<u>Section 5.7.3 - Presentation of Risk (Page 118, ¶3)</u>**

Sediment concentrations of contaminants are proposed to be compared with both NOAA sediment benchmarks and EPA sediment criteria. Revise the work plan to clearly state that the Equilibrium Partitioning method will be used to calculate sediment criteria for those non-polar organic contaminants that do not have EPA sediment criteria.

The following sentence will be added as the second sentence to the last paragraph on page 118:

For non-polar organic compounds for which no EPA sediment criteria are available, the Equilibrium Partitioning approach will be used to calculate sediment based on EPA and/or Connecticut water quality criteria.

39. **<u>Section 6.1.1.1 - Potential ARARs (Page 119)</u>**

Revise the work plan to present the comparison of the detected contaminant concentrations to the current federal drinking water standards; this may result in additional contaminant concentrations exceeding ARARs. If this comparison results in additional contaminant concentrations exceeding ARARs, then incorporate this information into the narrative. This revision should also ensure that only the most recent federal drinking water standards are used in this investigation.

We will screen the Phase I data regarding any recent changes in ARARs and revise this section of the report as necessary.

A table containing the most recent chemical-specific ARARs will be provided in the work plan and we will clarify that it is our intent to use the most recent ARAR data to evaluate all Phase II data.

40. **<u>Section 6.1.4.1 - Potential ARARs (Page 123, ¶6)</u>**

This paragraph contains an example of the inappropriate comparison of the lead concentration in soil (in solid form, mg/kg) from routine CLP chemical analysis to the concentration of RCRA TCLP regulatory level (i.e., 5 mg/L in solution) and CRDL (0.05 ug/L, in solution). This approach is incorrect.

Under the Resource Conservation and Recovery Act (RCRA) program, the leached concentration of a chemical in the soil, after conducting the Toxicity Characteristics Leaching Procedure (TCLP) analysis, is compared to a regulatory level to determine if the excavated soil is to be handled as a hazardous waste. This comparison is not to be used to determine if the soils pose a risk to human health or the environment based on a risk level or a hazard index.

Revise the work plan to reflect the correct approach to evaluating ARARs.

Please refer to our response to Comment 5 above.

41. **<u>Table 6-5 - Preliminary Remedial Action Objectives and Alternative Process Options (Page 124)</u>**

Revise this table to include a Remedial Action Objective (RAO) which addresses ground water contamination, since ground water has been determined to be contaminated with, at a minimum, vinyl chloride, benzene, toluene, ethylbenzene, xylene and PAHs.

Please refer to our response to General Comment 19 above.

42. **<u>Section 7.2.1 - Rubble Fill at Bunker A-86 (Page 136, ¶2)</u>**

Revise this list of contaminants for which the source, nature and extent will need to be defined to include chlorinated solvents.

This revision will be made.

43. **Section 7.2.1 - Rubble Fill at Bunker A-86 (Page 136, ¶4)**

Given that bedrock is exposed in the area, it is possible that contaminants may be released directly to bedrock, and therefore may not be detected in the overburden, if present.

Revise the work plan to include one shallow bedrock well clustered with an overburden well in order to determine the vertical flow gradient and contaminant levels in this area.

Please refer to our response to General Comment 20 above.

44. **Table 7-8 - Rationale for Selection of Constituents for Analysis (Page 138)**

Revise the engineering characteristics of the work plan to include the measurement of the subsurface soils and/or fill material pH in the contaminated area.

Definition of parameters such as compaction, percent moisture, permeability, strength, pH, etc. need to be proposed for the fill material and surrounding soils. The feasibility of capping may be greatly affected should the fill need compaction, or the fill not be strong enough to support the heavy machinery needed or the weight of the cap over time.

Revise the work plan to include efforts to characterize and delineate the fill material.

The engineering characteristics will be revised to include pH.

For the materials believed to be present, consolidation tests do not appear to be necessary. Standard penetration tests will be performed for borings in this area. The results of the penetration tests along with the parameters proposed will be adequate to predict the ability of soils in this site to support heavy equipment or a cap.

The work plan will be revised to include a task to identify the extent of fill based on visual observations.

45. **Table 7-9 - Rubble Fill at Bunker A-86, Field Sampling Plan (Page 139)**

Revise the work plan to include the addition of a surface water sample at location 4SD2 to measure the level of sediment contamination leaving the site.

Sample 2WSW13 was proposed for this purpose. Its location and designation will be changed to location 4SW2.

46. **<u>Figure 7-3 - Rubble Fill at Bunker A-86, Field Sampling Plan (Page 141)</u>**

Geophysical work or additional borings need to be proposed to confirm the interpreted extent of fill material. This information will be needed to determine the volume of material which will require treatment.

Provide the rationale for the collection of only one surface soil sample (of eight proposed) from the suspected source area. Revise the work plan to include two additional surface soil samples from the suspected source area.

As stated above, the extent of fill will be determined by visual observations and its depth will be determined by a soil boring. As we discussed, this will be adequate to determine the volume of fill.

The work plan will be revised to include the collection of two additional surface soil samples.

47. **<u>Section 7.2.2 - Torpedo Shops (Page 142, ¶1)</u>**

Revise the work plan to include Otto fuel and PCBs in the list of contaminants for which the source, nature and extent need to be defined.

This section will be revised to include as an objective, the determination of the extent of Otto fuel spillage; however, we don't feel delineation of PCB contamination is a goal of this investigation as PCBs have not been detected in ground water and only twice in soils at levels below 1 ppm.

48. **<u>Section 7.2.2 - Torpedo Shops (Page 142, ¶4)</u>**

Revise the work plan to indicate how the results of the soil gas surveys will be used (e.g., indicate whether any of the proposed sample locations will be re-positioned, or new locations will be added based on survey results, etc.). Include in this revision the criteria that will be used to decide these issues.

This will be provided.

49. **<u>Section 7.2.3 - Goss Cove (Page 142)</u>**

This section of the work plan proposes the measurement of air quality for the risk assessment, yet there is no mention of air pathway in the risk assessment section of this work plan.

Revise the work plan to clarify the status of the air pathway investigation.

Inhalation is indicated as an exposure pathway in the risk assessment work plan.

50. **<u>Table 7-11 (Page 144)</u>**

Revise the work plan to include the measurement of the heat content of soils (BTU analysis), porosity, and hydraulic conductivity in the engineering characteristics parameter.

Engineering parameters have been re-evaluated and a table will be provided containing our rationale. For the reasons presented below, we do not propose to add certain parameters:

- ***BTU** - No free oil or other organic product contamination is present and organic content is being measured. Typically, soils have no significant BTU value.*
- ***Porosity** - This parameter can be estimated to the accuracy necessary for any calculations in which it may be used.*
- ***Hydraulic Conductivity** - In situ tests are proposed to measure this characteristic.*

51. **<u>Table 7-12 (Page 145)</u>**

The U.S. Navy has indicated in the response to EPA comments regarding the August 1992 RI Report (Navy Summary of Resolutions Reached Regarding EPA Comments (May 20, 1992) on Draft IR Report (August 1991), Comment No. 1, for Page 29, Response 6, located on Page 8 of Navy Response), that samples would be obtained for dioxins at this site.

Revise the work plan to include the addition of the collection and analysis of samples for dioxins.

Revise the work plan to include engineering analysis at sample location 7MW2D.

The torpedo shops were listed in our previous response as dibenzofurans were detected in sample 2WSD9. We now classify this area as the Weapons Center site and have proposed dioxin analyses for sample 2WCSD11 near the location of 2WSD9.

The work plan will be revised to include engineering analysis at sample location 7MW2D.

52. **<u>Figure 7-4 (Page 147)</u>**

Revise the work plan to include the addition of a monitoring well hydraulically downgradient of monitoring well 7MW3 to determine the downgradient extent of contamination which has been observed in monitoring well 7MW3.

Include in the revision to this figure the location and discharge point of the floor drains which have been determined to contain volatile organic compounds.

Revise this figure to indicate the areas referred to as "where chemicals were stored (Page 142, ¶4)."

The revision to this figure should also include the sample locations from the GZA study in order to evaluate the sample locations around the Otto Fuel Tank Area.

Since the GZA study identified contamination around Building 450, revise the work plan to include additional soil and ground water sampling location around Building 450 to determine the nature and extent of the contamination identified in the GZA study.

There are already several wells (7MW9S, 2DMW29S and 2DMW28S and 2DMW28D) downgradient of 7MW3 that will be analyzed for VOC. These wells are shown on Plate 1. Due to the existence of these wells and as VOC levels in 7MW3 were below ARAR values, we do not feel any additional wells are necessary.

The floor drains discharged to the Otto fuel tank. Their location will be shown in Figure 7-4.

The areas where chemicals have been stored are at boring locations 7TB9 and 7TB7. These locations will be shown in Figure 7-4.

The former GZA sample locations, which are all at the Otto fuel tank, will be shown. Wells 7MW5S and 7MW5D, borings 7TB11, 7TB12, 7TB13 and supplemental borings were proposed for this purpose and should adequately make this determination.

53. <u>Section 7.2.3 - Goss Cove (Page 148)</u>

One of the stated objectives for Goss Cove is to confirm that radiological constituents in ground water are from natural sources. However, analysis for radiological parameters in ground water is only planned for the existing 8MW1 and 8MW4. Confirmation sampling at these locations will not determine whether the previously observed levels of radiological analytes are occurring at "natural levels".

Revise the work plan to include sampling of upgradient wells to help determine the background level of the previously detected radioisotopes.

As we discussed in our phone conference, the background determination regarding radiological parameters will be made by performing a gamma spectrum analysis rather than by background comparison.

The text will be clarified regarding performance of the gamma spectrum analysis.

54. <u>Section 7.2.3 - Goss Cove (Page 148, ¶4)</u>

Revise the work plan to clearly state the specific criteria which will be employed in determining how the results from the field screening will be used to determine if additional borings are required.

Composited samples may be used to generally characterize the nature of the fill material as a potential source of any contaminants detected in the area of the landfill. However, composited samples will not "properly characterize the nature, extent and degree of contamination". Composited samples would potentially result in the dilution of contaminants and therefore, would be an inappropriate representation of the degree of contamination.

Revise the work plan to ensure that all subsurface soil samples (especially samples for VOC analysis) will be collected as discrete grab samples.

The details regarding sample selection are provided in the Field Sampling Plan (FSP). Please refer to Section 4.2.2.3 in the FSP.

Vertical composite sampling (except for VOCs) was proposed; it is our opinion that due to the heterogeneous nature of the landfill contents, the risk of missing significant contamination is much greater than masking significant levels of contamination due to dilution. Dilution levels assuming one sample is contaminated and all others are clean will not exceed a factor of 10. As we discussed, we feel compositing is a better approach; however, if EPA feels strongly that we collect grab samples instead, the work plan will be revised accordingly. The number of samples analyzed does not change either way. It should be noted that surface samples are not being composited.

The work plan does not propose the compositing of VOCs and is clear on this point.

<u>EPA's Comment on Navy Response</u>

Revise the work plan to state that samples will not be composited. Samples should be collected based on visual observation and field screening measurements. Compositing of samples for parameters, other than Volatile Organic Compounds (VOCs), may be acceptable only if insufficient volume is available for all of the analyses.

55. <u>Table 7-15 - Goss Cove Landfill, Field Sampling Plan (Page 151)</u>

Revise the work plan to include the rationale that was used to select the locations and depths from which samples will be collected for the analysis of engineering properties.

Include in this revision, the analysis of pesticides in ground water since pesticides were detected in soils at this site.

Samples for engineering analysis were selected to be from the screened interval of a *monitoring well or in areas that may require remediation. This rationale will be provided in the work plan.*

We did not include the analysis of pesticides at this site as they were not detected in previous analyses.

56. **Figure 7-5 - Goss Cove Landfill, Field Sampling (Page 154)**

The U.S. Navy should consider gathering an additional sample along the bank of the Thames River north and upstream of the pier, yet south and downstream of the storm drain outfall. It is recommended that the sample analysis include CLP TAL and TCL, TPH, TOC, and a grain size determination.

Revise the work plan to include, as a water quality parameter, the measurement of water hardness for surface water samples.

A sample location is already proposed just north of this location and as this area is subject to tidal currents, significant differences between adjacent sample locations are not expected. If this particular location is of concern, the plan will be revised to show the proposed Goss Cove sample location at this location.

The work plan proposes to measure hardness in surface water. The text will be clarified to make this clear.

EPA's Comment on Navy Response

No sample location is visible on the Goss Cove map (Figure 7-5, page 154 in the Field Sampling Plan) in the Thames River immediately north of the proposed location. This specific sampling location (north and upstream of the pier, yet south and downstream of the storm drain outfall) is of concern to EPA, as this area is suspected of potential discharges.

57. **Table 7-16 - Spent Acid Storage and Disposal Area Remedial Investigation Objectives (Page 156)**

Revise the work plan to include performing hydraulic conductivity testing in additional wells. This is necessary since many Phase I hydraulic conductivity pump test results were not useable.

Also include in this revision the specific criteria regarding the results of X-ray fluorescence screening. Describe how the samples will be selected for chemical analysis (e.g., highest detection, deepest detection, at the water table, etc.).

The plan will be revised to perform an additional hydraulic conductivity test in well 15MW3S.

The criteria for sample selection are provided in the FSP. Please refer to Section 4.2.2.4 in the FSP for these details.

58. **Table 7-18 - Spent Acid Storage and Disposal Area, Field Sampling Plan (Page 158)**

Revise the work plan to include a bedrock monitoring well to evaluate the transport pathway indicated in the conceptual model (Figure 3-4). In addition, provide the rationale used to select the locations and depths from which samples will be collected for analysis of engineering properties.

The installation of a bedrock well will be added at this site.

The work plan will be revised to provide rationale for selection of samples for engineering analysis. Further detail regarding this point is provided in the response to Comment 19 above.

59. **Section 7.3.1 - Area A (Page 161)**

The eighth bullet of this section proposes verification sampling to determine whether previously detected radiological contamination is naturally occurring; however, this repetitive effort will help further determine the background level of the radiological compounds.

Revise the work plan to include a series of background sampling locations to assist in this determination. These additional sampling points should be located upgradient of these areas known or suspected contamination.

Please refer to our response to Comment 52 above.

60. **Table 7-19 - Chemical Investigation, Surface Water North Lake (Page 164)**

This statement states that surface water will be taken "during non-summer months and/or when the lake is drained". Revise the work plan to ensure that the surface water samples will be collected prior to the actual draining of the lake.

The same logic would apply to the collection of sediment samples from the North Lake. Revise the work plan to ensure that the sediment samples will be collected prior to the actual draining of the lake.

As we discussed, the work plan will remain as proposed and provide for collection of samples when the lake is drained.

EPA's Comment on Navy Responses

For clarification purposes, the work plan should state that surface water and sediment samples will be taken at proposed sampling locations prior to the actual draining of the lake.

61. **Table 7-20 - Area A, Rationale for Selection of Constituents for Analysis (Page 166)**

Subsection 2.4.1.3 of the work plan states that pesticides were detected in three subsurface soil samples and yet does not discuss whether or not they were detected (or analyzed for) in ground water.

Revise the work plan to include pesticides in the proposed ground water analyses.

Table 7-20, Page 166 states that pesticides were not detected in ground water and for that reason, are not proposed to be analyzed for in ground water.

62. **Table 7-21 - Area A, Field Sampling Plan (Page 168)**

Revise the work plan to include the analysis for PCBs in the ground water samples collected from monitoring wells 2WCMW1S, 2S, 3S.

Ground water analysis was not proposed for these wells as PCBs have not been detected in ground water in this area during the Phase I RI.

63. **Figure 7-7 - Area A Landfill, Wetland and Weapons Center, Field Sampling Plan (Page 173)**

The ground water flow arrows on this map are not accurate, and is not clear whether they depict flow in the overburden or bedrock. In addition, it is not possible to determine whether the proposed monitoring wells are optimally located.

Revise the "Ground Water Flow Direction" arrows to correspond to flow path lines which have been constructed based on potentiometric maps and add information to this map which will indicate the variation of the vertical gradient across the site. Include in the revised work plan, a ground water elevation map, a bedrock elevation map, and a map of the extent of contamination observed in previous studies.

The flow arrows are accurate; however, we agree to clarify that these arrows are for overburden ground water flow.

64. **Table 7-22 - DRMO, Remedial Investigation Objectives (Page 175)**

Revise the work plan to include the rationale for the selection of only wells 6MW4S and 6MW3D for hydraulic conductivity testing.

Confirmation sampling for radiological parameters at the proposed locations will not determine whether the previously observed levels of radiological analytes are occurring at "natural levels".

Revise the work plan to include a series of background sampling locations to assist in this determination. These additional sampling points should be located upgradient of these areas known or suspected contamination.

The rationale will be provided.

Radiological background levels will be determined by use of a gamma spectrum analyses. Please refer to the response to Comment 52 above for further detail.

65. <u>**Section 7.3.3 - Lower Subase (Page 177, ¶3)**</u>

The U.S. Navy has previously reported that VOCs such as vinyl chloride, benzene and floating product layers have been detected in ground water.

Revise the work plan to include the determination of the extent of VOC contamination in ground water as one of the goals of the Phase II RI.

VOCs have been detected in ground water, however, no recoverable floating product layers were detected during the Phase I RI investigation. The thin layer at 13MW5 which was more of a sheen, does not indicate the presence of a pool of floating product.

There are 24 existing wells at the Lower Subase which is located along the Thames River. This existing monitoring system does define the extent of contamination at this site as detailed in the Phase I RI Report.

<u>**EPA's Comment of Navy Response**</u>

They should review the proposed sampling approach for the area surrounding the former power house tanks and suggest an approach which will allow adequate characterization of the subsurface. Suggested investigative techniques include microwells, angle borings and geophysical methods.

66. <u>**Figure 7-9 - DRMO, Field Sampling Plan (Page 180)**</u>

Revise the work plan to include a figure defining the suspected extent of fill material.

The DRMO figure will be revised to show the extent of fill material.

67. <u>**Table 7-25 - Lower Subase (Page 181)**</u>

Revise the work plan to include the installation of additional ground water monitoring wells in the area of 13MW5 and the tanks in order to determine the extent of the floating layer observed at this location.

Revise the Remedial Investigation Objectives of the work plan to include determining the extent of VOC contamination in ground water.

As stated above, no floating oil was detected during the Phase I and the extent of VOC contamination has been identified.

<u>**EPA's Comment of Navy Response**</u>

They should review the proposed sampling approach for the area surrounding the former power house tanks and suggest an approach which will allow adequate characterization of the subsurface. Suggested investigative techniques include microwells, angle borings and geophysical methods.

68. <u>**Figure 10-1 - Project Schedule (Page 196)**</u>

Revise the project schedule to the schedule listed in the Federal Facility Agreement (FFA) or submit a petition for a schedule extension. This petition for schedule extension should include a detailed description of the level of effort that the U.S. Navy will be requiring to justify the additional time.

This was provided to EPA in a letter dated January 8, 1993.

PROPOSED FIELD SAMPLING PLAN

GENERAL COMMENTS

1. It appears that for many sediment samples, the "engineering" characteristics are not going to be examined. In order for the sediment sample to be useful for an ecological risk assessment, the total organic carbon (TOC) content and grain size distribution must be determined.

   The plan will be revised to provide for testing all sediment samples for TOC and grain size.

2. There seems to the lack of distinction between the use of terms "soils" and "wetland sediments" when analyses and sampling are discussed. "Wetland sediments" should be termed "wetland soils" and the term "sediments" should be used when referring to the samples below the surface of the water.

   Revise the work plan to ensure that these terms are not used interchangeably, especially in the tables.

   The work plan will be revised to use consistent terminology regarding soils, wetland soil, sediments and wetland sediments.

3. The air monitoring activities discussion in Section 4.1.12 of the Field Sampling Plan makes reference to U.S. EPA Method T01, a copy of which is included in Appendix A.

   Revise the work plan to include Standard Operating Procedures (SOPs) covering all aspects of sampling and analysis for volatile organic compounds (VOCs) and any other contaminants monitored at the site (see Attachment B).

   An SOP for air sampling will be provided.

SPECIFIC COMMENTS

1. **Section 2.1 - Supplemental Step II Investigation (Page 7)**

According to page 1 of the Field Sampling Plan, these sites are to be part of the Supplemental Step I, yet this page indicates that these are part of a Supplemental Step II Investigation.

Revise the work plan to clarify the status of these areas.

Section 2.1 will be revised to indicate that supplemental Step I (not Step II) investigations are proposed for CBU and OBDANE.

2. **Section 4.1.1.1 - Sample Headspace Screening for VOCs (Page 16, ¶3)**

Clarify the statement "Resulting data will not be used qualitatively".

This sentence should read "Resulting data will not be used ***quantitatively.****"*

3. **Section 4.1.1.2 - PCBs and DDT Screening and Section 4.1.1.4 - Lead Screening (Page 18)**

Revise the work plan to include the detection limits for the field screening methods.

A discussion of detection limits for the field screening methods will be provided. Practical quantitation limits range from 1-10 ppm for DDT and PCB using GC methods and 100 - 500 ppm for lead analyses using XRF.

4. **Section 4.1.3 - Test Borings and Subsurface Soil Sampling (Page 19, ¶3)**

It is strongly recommended that the work plan be revised to include the use of an alternative method of collecting soil samples. The use of 5-foot Central Mining Equipment (CME) is not encouraged due to problems associated with sample recovery.

Revise the work plan to ensure that all test borings are advanced to bedrock to a minimum of five feet to verify the presence of bedrock.

The field sampling plan provides two alternatives to a CME sampler; split spoon samplers and saturated sand samplers. We recognize the limitations of a CME sample and will only use it at sites where it will successfully recover samples.

To define bedrock, the work plan will be revised to core five feet into bedrock at each site at specified locations. One location will be established at Rubble Fill and Spent Acid, two at Goss Cove, Torpedo Shops and DRMO, and four at Area A.

5. <u>Section 4.1.4.1 - Monitoring Well Construction (Page 19, ¶4)</u>

Revise the work plan to include a description of the type of well construction materials planned for the Spent Acid Disposal Area considering that the soil pH is low.

A description of well construction materials is provided in Section 4.1.4.1 and Appendix B of the Field Sampling Plan. PVC is compatible with low pH material.

6. <u>Section 4.1.4.1 - Monitoring Well Construction (Page 20, ¶3)</u>

Revise the work plan to ensure that the maximum well screen length will be no greater than 10 feet.

Revise the work plan to indicate that the mud rotary drilling method will only be used as a last resort if no other well installation methods are successful.

The work plan specifies that all well screens be 10 feet or less in length except at the Torpedo Shops. At this site, due to the shallow depth to bedrock and potential chlorinated VOC and petroleum contamination, it was felt that it was important to screen from above the water table to the bedrock surface even if more than 10' of screen are required. We do not anticipate any screens greater than 15' in length at this site and will specify a maximum of 15 feet at this site.

<u>EPA's Comment of Navy Responses</u>

No well screens shall be longer than 10 feet. If the thickness of the saturated overburden is such that longer well screens are desired, then additional wells should be installed.

Revise the work plan to state that mud rotary drilling will only be used after all other methods have failed. EPA - Region I only authorizes the use of mud rotary drilling in extremely deep wells (typically over 200 feet).

7. <u>Section 4.1.4.2 - Monitoring Well Development (Page 20, ¶4)</u>

Revise the work plan to indicate that well development will proceed until three successive measurements of specific conductance, temperature and pH have stabilized (i.e., vary less than 10 percent) and turbidity is less than 5 NTUs, or until three well volumes have been removed.

The development procedures will be revised as suggested, except that per our discussion, well development will continue until a minimum of seven well volumes have been removed or four hour have elapsed, which ever is greater.

8. <u>Section 4.1.4.3 - Monitoring Well Sampling (Page 20, ¶5)</u>

Revise the work plan to ensure that ground water samples will remain unfiltered prior to analysis.

The work plan clearly specifies that ground water samples for metals analysis will be analyzed on both filtered and non-filtered samples and does not specify the filtering of any other ground water samples.

9. **Section 4.1.5 - Evaluation of Aquifer Hydraulic Properties (Page 22, ¶1)**

Revise the work plan to provide additional details regarding the Area A pump test. Include in this revision a description of which wells will be used as observation wells, how long the test will run, how the purge water will be managed (i.e., disposed), degree of recovery which will be measured (90 percent), frequency of measurement of water levels, etc. Ensure that the pumping test plan includes the monitoring of bedrock well water levels.

The additional detail regarding the proposed pump test will be provided.

10. **Section 4.1.14 - Sampling and Testing of Soils for Engineering Parameters (Page 24, ¶4)**

Revise the work plan to clearly state whether all of the proposed engineering analyses will be performed for all sites. Some of the engineering analyses may not be needed at all sites.

It is recommended that additional testing for compaction and strength be performed at Goss Cove, DRMO, and the Area A Landfill. As mentioned previously, this information may be critical in determining whether these areas will be capable of accepting some of the remedial alternatives.

The text suggests that the Walkley-Black method will be used to determine the Total Organic Carbon (TOC) content. However, the NET Quality Assurance Project Plan (QAPP) lists two other methods, 415.2 and 9060. Revise the work plan to clearly state the method that will be used for TOC determinations.

Revise the work plan to identify the laboratories that will perform the engineering analyses, the radiological analyses, and the air sample analyses. The NET QAPP does not list these methods on the qualifications statement.

Whether or not engineering analyses will be performed at a particular location is specified in the FSP and the specific parameters in the engineering analysis are presented in the rationale for selection of constituents for analysis tables.

Please refer to the response to Comment 44 above regarding the need for compaction tests.

The work plan will be clarified to specify only the Walkley-Black Method for TOC *analysis.*

These subcontractors have not been selected at this time. When this contract amendment has been finalized, EPA will be notified as to who will do the work. Whoever does the work will follow the procedures specified.

11. <u>**Section 4.2.2.4 - Spent Acid Storage and Disposal Area (Page 47, ¶5)**</u>

Revise the work plan to include the collection of a complete round of monthly water level measurements for all monitoring wells on the base to produce a series of ground water elevation maps. These ground water maps would depict the ground water flow directions and flow divides.

The Navy has agreed to develop a basewide ground water contour map and proposes to measure elevations in all wells at the base once. The only areas where it is necessary to measure on a more frequent basis are those areas where there is some uncertainty regarding ground water flow direction such as North Lake and Area A Wetlands. Regarding these areas, after further evaluation, we are proposing to change the frequency specified in the work plan from monthly to quarterly.

<u>**EPA's Comment on Navy Response**</u>

A subset of 20 to 30 well clusters should be identified as candidates for monthly water level measurements. The objectives of the water level measurements are to determine: seasonal changes in vertical gradients; annual variation in water levels; hydraulic connection between the Thames River, overburden and bedrock; response of water levels to precipitation events.

In addition to aiding the characterization of the subsurface hydrogeology, this data will be required at any of the sites where capping or ground water treatment will be considered as a remedial alternative.

The list of proposed wells should be included in the revised work plan or submitted to EPA separately for review.

12. <u>**Table 4-15 - Area A, Field Sampling Plan (Page 54)**</u>

Table 4-15 proposes that *in situ* earthworm bioassays be used in "soils/wetland sediment". If the purpose of a bioassay is to assess the suitability of sediment for benthic organisms, then the use of earthworms in a soil bioassay is of questionable value.

If the U.S. Navy is proposing to use *in situ* earthworm bioassays to assess the suitability of sediment for benthic organisms, then provide the supporting rationale for this proposed method.

Earthworm bioassays are suitable for wetland sediment/soil where the soil may be dry *enough for part of the year to support these organism. Their use in this manner has been documented by Menzie et al. (1992) among others. Callahan (1993, personal communication) and research by Mac et al. (1990) indicate that it is possible to use earthworms to assess the toxicity of aquatic sediments. Refer to the response to comment number 30 on the work plan for additional information on the use of earthworms in sediment bioassays.*

13. <u>Section 4.2.3.1 - Area A (Page 57, ¶1)</u>

Revise the work plan to ensure that all test borings are advanced to the water table.

This paragraph states that all borings will be advanced to a depth of 15 feet or the water table, whichever is greater.

14. <u>Section 4.2.3.1 - Area A (Page 58, ¶1)</u>

The objective of simulating residential well water withdrawal does not appear to be appropriate. The focus of the bedrock wells should be to determine whether ground water is contaminated. It is possible that the reason the residential wells have not previously contained organic contamination, is that they are open over long intervals potentially resulting in an off-gassing of the contaminants.

Revise the work plan to indicate that bedrock wells will be advanced until they are capable of providing a reasonable sustainable yield (e.g., over one gallon per minute).

Both the EPA and CTDEP commented on the bedrock well design. EPA suggested to drill the bedrock wells to the depth at which they are capable of providing a yield greater than 1 gpm and stated that the objective of simulating water withdrawal is not appropriate. CTDEP suggested that continuous packer tests be performed in one or two wells and that well screens be set in the highest water yielding zone. CTDEP also stated that the zones of highest yields will be representative of the primary source of water to residential wells. During our phone conference, EPA felt after discussion that the CTDEP packer testing approach was preferable. Packer testing would be capable of defining the highest yield zone in a well, however, whether or not this is the most appropriate zone to sample bears some discussion. The highest yielding zone may not be the most contaminated zone or contaminated at all. Sampling every zone is not feasible and will not substantially add to our understanding of the site. We disagree with EPA that the objective of simulating well water withdrawal does not appear to be appropriate. Remediation standard for this area will be based on MCLs which are measured at the tap not in situ. We feel the objectives of these wells should be to simulate residential wells and detect contamination. Packer testing and screening at the highest yielding zone may not detect contamination in low yielding zones. Drilling to the first water bearing zone could result in the non-detection of contaminants in deeper zones. The effects of dilution of any particular water bearing zone in a deep well must be evaluated regarding contaminant detection. In a hypothetical 100 foot deep bedrock well containing ten different zones, one yielding 1.0 gpm and the others yielding 0.1 *gpm, dilution factors are 1.9 to 1 for contaminants in the high yield zone and 19 to 1 for each of the low yielding zones. With this in mind and after consideration of EPA and CTDEP comments, the design in the work plan, seems preferable to either alternative as it will detect any significant contamination and it accurately simulates a residential well for comparison to MCLs.*

15. <u>**Section 4.2.3.1 - Area A (Page 58, ¶3)**</u>

Revise the work plan to indicate the proposed location of the observation wells and revise the narrative to include the gathering and analysis of ground water samples from the pumping well. These ground water samples would be analyzed for volatile organic compounds (VOCs) at the following intervals during the pump test: start, 1 hour, 2 hours, 4 hours, 8 hours, 16 hours and at the conclusion.

The work plan will be revised to show the location of the observation wells and will provide for collection of seven samples at the intervals indicated in the comment.

16. <u>**Section 4.2.3.1 - Area A Wetland (Page 59, ¶3)**</u>

It is unclear how the water levels in residential wells will be measured, since this will require removing pumping appurtenances, and discontinuing water removal for a period of time long enough to ensure stabilization of water levels.

Revise the work plan to include a discussion of how the water levels of the select residential wells will be measured.

We will perform the measurements at select locations which have well casings completed above grade at residents who agree not to use water for a minimum of an hour prior to the measurements. With casings above grade, the cover/seal can be removed. There is enough clearance in the well casing to allow insertion of a water level indicator without removing any pumping apparatus.

17. <u>**Section 4.2.3.2 - Defense Reutilization and Marketing Office (DRMO) (Page 63, ¶5)**</u>

Revise the work plan, if necessary, to ensure that soil samples gathered for VOC analysis are not composited.

Revise the work plan to ensure that deeper soil samples (below one foot) will be gathered for the risk assessment to evaluate exposure of construction workers.

The FSP is clear on the point that samples for VOC analysis will not be composited. The plan states that deeper soil samples will be used in the risk assessment.

18. <u>**Section 5.0 - Sample Preservation and Shipping (Page 75)**</u>

More detailed information needs to be provided in this section. Specifically, describe the following:

- the method to confirm the pH of the samples
- describe the pH at which the samples will be preserved and the preservative(s) that will be used in this effort

Provide a table that includes this information. This information must also be incorporated into Section 3.3 of the QA/QC Plan.

This information will be provided. Samples will be acidified to a pH less than 2 using nitric acid. To verify pH, a sample that will not be sent to the lab will be analyzed for pH as increasingly larger volumes of acid are added to the sample until its pH is ≤2. This volume plus 25 percent will be used to preserve all other samples.

19a. <u>**Appendix A - SOPs, Technical Procedures**</u>

Revise the work plan to include a description of who will be performing these analyses and describe if all the methods listed in this table are to be performed in the field. For additional reference, see Attachment B.

All of the methods will be performed in the field except ASTM Methods D854, D2216, D2974 and possibly D422, SW-846 Methods 9045 and 9081 and EPA T01. Whoever performs the analyses will follow the procedures indicated. Presently, it is planned that Atlantic will perform all field analyses except XRF analyses which will be performed by a subcontractor.

19b. <u>**SOP 1020 (Page 5, ¶1)**</u>

Revise the work plan to ensure that samples will not be composited.

Neither the work plan or Atlantic SOPs allow VOC to be composited. Regarding the compositing for non-VOC analyses, please refer to our response to Comment 53 above.

19c. <u>**SOP 1022 (Page 7)**</u>

Revise the work plan to include the following statement to the text; "the samples will be immediately preserved after filtration".

The specified statement will be included in the work plan.

19d. <u>**SOP 1023 (Page 7, ¶3)**</u>

Revise the work plan to indicate that no filtering of ground water will be performed.

Samples for inorganic analyses will be analyzed for filtered and non-filtered metals. No other samples will be filtered.

19e. **SOP 1060**

Revise the work plan to ensure that this procedure will be modified to correspond to EPA Region I protocol.

To what extent does this SOP not agree with Region I protocol?

QUALITY ASSURANCE/QUALITY CONTROL DATA MANAGEMENT PLAN

1. <u>Section 1.1 - Data Quality Objectives (DQO) (Page 1)</u>

   The references to both the SOWs and Data Validation Functional Guidelines are not current. The NET QAPP indicates that it follows the 3/90 CLP SOWs.

   Revise the text of the work plan to reflect the 3/90 SOW and the U.S. EPA Region I Laboratory Data Validation Functional Guidelines for Organic Analyses February 1, 1988, modified July 1988 and U.S. EPA Region I Laboratory Data Validation Functional Guidelines for Inorganic Analyses June 13, 1988, modified February 1989.

   The plan will be revised to reference the documents specified.

2. <u>Section 1.1 - Data Quality Objectives (DQO) (Page 1, ¶6)</u>

   The text cites the 7/88 and 2/88 Statements of Work for inorganics and organic CLP procedures, yet Section 8, Page 2 of the NET Quality Assurance Plan cites the 3/90 Statements of Work.

   Revise the text of the work plan to ensure consistency.

   The work plan will be revised to only reference the 3/90 SOW.

3. <u>Section 2.0 - Project Organization and Responsibilities (Page 4)</u>

   Modify Section 2.0 of the work plan to identify the individuals responsible for the validation of analytical chemical data and include their qualifications for this activity.

   The data validation subcontractor has not been selected; however, the qualification for META who will be validating the Phase I and Pier 33/Berth 16 data will be provided under separate cover.

4. <u>Section 3.3 - Sample Collection, Handling and Shipment (Page 8)</u>

   Potential interferences may be caused by some of the constituents that make up the flint glass products.

   Revise the work plan to ensure that soil samples will be collected in 40-ml vials unless information can be provided demonstrating that the 60-ml vials are made of borosilicate glass rather than flint glass.

   The text references the NET QAPP for sample containers, preservatives, and holding times. The referenced table does not provide this information for all of the proposed analyses (e.g., dioxins and radiologicals).

Revise the work plan to provide this information in a table format with this information presented by method and matrix.

Use of borosilicate glass for these samples will be specified. The referenced table will be revised to include the required information for dioxins and gross alpha, gross beta and gamma spectrum analysis.

5. <u>Table 3-1 - Frequency of Field QC Samples (Page 9)</u>

Revise the work plan to ensure that equipment blanks will be collected at a frequency of one per day per matrix per piece of equipment for non-dedicated equipment.

The plan will be revised to provide for collection of equipment rinsate at a frequency of one per day per matrix per piece of equipment for non-dedicated equipment.

6. <u>Section 3.4.4 - Field Duplicates (Page 10)</u>

Field duplicates are two separate samples collected from the same source.

Revise this section of the work plan to reflect this definition.

The work plan will indicate that field duplicates are two separate samples collected from the same source.

7. <u>Section 5.1.1 - Organic and Inorganic Analyses (Page 13)</u>

Section 5.0 of the QA/QC Plan lists several options for analysis of water and soil rather than clearly specifying the exact procedure to be analyzed for each of the analytes of interest. For example, it is unclear whether some water samples will be analyzed by CLP protocols and some by EPA Method 524.2 or whether all water samples will be subjected to the low level VOC procedure (Method 524.2). Boring analysis procedures are of particular interest, since boron is not on the CLP metals analyte list. Yet the QAPP refers to a list of manuals of which five provide several optional metals analysis procedures.

Revise the QA/QC Project Plan to include a table listing the analysis method and reference for each matrix and parameter of interest.

The specific methods used for this site for the "non-CLP" analyses must be specified since NET QAPP lists more than one method for the same parameter. Revise the work plan to specifically describe these above-mentioned methods.

Include in this revision a description specifying the time when the low-level VOC samples are to be collected. Neither the FSP or the QAPP has discussed these samples prior to this section.

Project-specific methods will be highlighted in the QA/QC plan and the FSP table will be revised to indicate when low level VOC analyses will be performed.

8. <u>Section 5.2 - Field Procedures (Page 17)</u>

Reference is made in the text to EPA's Field Screening Methods Catalogue (EPA/540/2-88/005) for analytical procedures for PCB and metals screening. The document referenced is a compilation of available technologies which have been employed in onsite situations. It does not provide the SOPs which are necessary for conducting these analyses.

Revise the work plan to include the detailed SOPs for EPA to review. These SOPs should provide detailed descriptions of sample preparation, stock standard preparation, calibration standard preparation, instrument operating conditions, instrument calibration sequence, initial and continuing calibration acceptance criteria, instrument corrective action and maintenance, quality control sample preparation and acceptance criteria, example calculations and detection limits. See Attachment B for additional information regarding the development of SOPs.

SOPs will be provided for the following activities:

- *field analysis for PCB and DDTR using GC methods*
- *field analyses for lead using XRF methods*
- *air sampling for VOCs by EPA Method TO1*

9. <u>Section 6.0 - Data Validation (Page 18, ¶1)</u>

Revise the work plan to include the following dates of the Functional Guidelines:

- U.S. EPA Region I Laboratory Data Validation Functional Guidelines for Organic Analyses, February 1, 1988, modified July 1988

- U.S. EPA Region I Laboratory Data Validation Functional Guidelines for Inorganic Analyses, June 13, 1988, modified February 1989

Include a description of the personnel who will be performing the data validation and describe the data reporting methods.

The referenced dates will be included in the work plan. Please refer to the response to Comment 3 above regarding validation personnel.

10. **<u>Section 6.0 - Data Validation (Page 18, ¶2 and 3)</u>**

It is unclear which samples will be analyzed using CLP methods and consequently, validated using EPA Level IV validation protocols.

Revise the QA/QC Project Plan to specify which samples will be validated in accordance with EPA Level IV requirements.

Complete data packages for all constituents analyzed by CLP methods will be prepared and 10 percent of the CLP data will be validated using EPA Level IV validation protocols.

11. **<u>Section 6.0 - Data Validation (Page 18, ¶5)</u>**

Revise the work plan to include a detailed description of the calibration procedures to be utilized for soil gas analysis. Include in this description the source of reference standard, the concentrations of specific analytes in calibration standards and the acceptance criteria for calibration. Specify the number of duplicate samples to be evaluated in the laboratory.

This information will be provided.

12. **<u>Section 7.0 - Data Quality Objectives (Page 19, ¶1)</u>**

Contrary to the statement made in the text, data quality objectives cannot be found in Table 5-2 of Appendix A. Appendix A provides lists of QA objectives for several analysis procedures, but does not specify which objectives apply to samples to be collected during Phase II of the RI.

Revise the work plan in order to provide a table of project-specific QA objectives for each analysis parameter.

The project-specific QA/QC objectives will be highlighted in the applicable tables.

13. **<u>Section 7.2 - Accuracy (Page 19, ¶3)</u>**

The text makes generic statements about the assessment of accuracy which needs to be supported by summaries of the project-specific procedures. For example, the use of surrogate spikes to evaluate the accuracy of organics analysis is not cited although surrogate spiking is a typical requirement of analysis methods.

Revise this section of the work plan to cite or reference the accuracy objectives for the Phase II program.

This section will be revised to reference the accuracy objective for the Phase II program.

14. <u>Section 9.1 - Laboratory Data Management (Page 24, ¶4)</u>

Revise the work plan to include a description of the format in which laboratory data will be presented in the Phase II RI Report. This description should include the sample identification, the analysis method, the laboratory sample identification and date sampled.

The Phase I RI Report provided summaries of results only for those analytes detected at least once in the samples listed. No detection limits for undetected analytes were provided. This type of presentation is insufficient.

The Phase II RI Report should have, available upon EPA request, an appendix containing the complete validated analytical results for all parameters analyzed. The appendix should be formatted and cross-referenced such that specific analysis results can be located for review.

Revise the work plan to ensure that all of the analytical information is available to EPA for review.

Please refer to the response to Comment 5 in the work plan general comments section.

<u>EPA's Comment on Navy Response</u>

The response to the comment is answered by reference to Attachment 1 - Data Format Examples. These examples do not address all of EPA's concerns.

Modify the data format examples to include: the identification of the analytical methods (e.g., gross alpha, boron, CLP SOW identification); identify the detection limits; and identify the sample collection and analysis dates.

15a. <u>Appendix A - Section 7</u>

Revise this section of the work plan to cite the quality control objectives anticipated for this project. The quality control objectives anticipated for this project should be consistent with Section 7.0 of the QA/QC Plan.

The two sections will be coordinated and project-specific QA objectives will be highlighted in the laboratory QA/QC plan.

15b. <u>Appendix A - Section 7</u>

Revise Table 7-1 to specify control limits for boron and ensure that boron is included in all calibration verifications (initial and continuing), laboratory control samples, matrix spikes, interference check samples (for ICP analysis) and duplicate samples. Revise Table 7-1 to be consistent with the TPH analytical method and quality control requirements cited in Appendix C.

Table 7-1 will be revised as indicated.

15c. <u>Appendix A - Section 8</u>

This section provides a complete listing of all analytical methods utilized by NET, Inc.

Revise the work plan to include a project-specific listing of methods in this appendix or elsewhere in the QAPP. Boron should be added to Table 8-2.

All project specific analytical methods will be highlighted in this table.

15d. <u>Appendix A - Section 9</u>

Revise this section of the work plan in order to clarify the set of project-specific detection limits for all analytical protocols employed by NET, Inc.

All project-specific detection limits will be highlighted in this table.

15e. <u>Laboratory QA/QC Plan</u>

Addendum 4 contains a table that lists preservation and holding time requirements. The holding times listed must be from the time of sample collection (including those for CLP analyses). This table also lists the CLP requirements for metals, but no CLP designation has been provided for the organics, unless the NEESA designation is considered equivalent to the CLP for the purposes of this project.

Revise the work plan to clarify this discrepancy.

Holding times will be measured from the time the sample is collected and the wording regarding NEESA and CLP will be clarified.

ATTACHMENT A

AMBIENT AIR SAMPLING PLAN WITH QA/QC PROCEDURES

A work plan documenting all aspects of sampling, analysis and associated QA/QC must be prepared, reviewed and approved prior to any sampling effort:

1. Data quality objectives must be established, in order to determine whether any data collected will be relevant and useful. For example, if a risk assessment is to be performed, how many sampling stations and at which key locations will be required? Which species will be sampled for? Is the method to be utilized capable of quantifying those contaminants at the expected levels? Specify the detection limits expected under the proposed conditions.

2. Specification of the method to be utilized must include, for example, documentation of applicability to the species sought during sampling (provide a list of species expected to be found), and a detailed description of both sampling procedures and analytical procedures to be followed. Any deviations from referenced procedures must be thoroughly documented. Include the Standard Operating procedures specified by the method. In addition, data must be presented demonstrating the capability of the method to be used to attain the required quality of data under the actual sampling and analysis conditions anticipated (see Performance Criteria and Quality Assurance requirements delineated in each method).

3. Sampling and analytical procedures should be described in a sufficient level of detail to provide assurance that they will be performed in accordance with accepted quality control standards. The same general level of scientific rigor as adhered to in the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (EPA-600/4-84-041) must be demonstrated for any technique utilized, in order to lend credibility to the results.

4. Sampling locations should be specified and identified on a site map, including sufficient detail to show sources and directions of potential receptors. The map should be north-oriented and include a scale. Specify the expected prevailing wind speed and direction during the proposed sampling period, including a wind rose. Address sampling station issues such as provisions for security and electrical power, as applicable. The sampling Standard Operating Procedure must list all necessary equipment and supplies.

   Specify how flow rates and sampling times will be established.

   - What is the rejection criteria for pre/pose flow-rate calibration?
   - How will the sampling equipment be cleaned, and how will the requisite degree of cleanliness be demonstrated?
   - Will flow rates be corrected to standard conditions of temperature, pressure and humidity?
   - Specify laboratory, trip and field blanks and quality control duplicates, as well

as backup (secondary) cartridges where applicable.

5. Delineate the collection procedures for concurrent onsite meteorological data (specify equipment, siting criteria, calibration procedures, data recording and reduction, etc.). Attempt to conduct baseline ambient air monitoring under worst-case conditions (high temperature, low humidity, low wind speeds).

6. Include procedures for sample collection, handling, storage and transportation, including preservation methods and holding times. Specify chain-of-custody procedures.

7. <u>Additional Requirements</u>

   - What are the calibration procedures for the analytical instruments to be used? How will standards be prepared?

   - How will data from blank analysis be utilized? What is the limit of blank contamination for which data will be acceptable?

   - Will backup (series) cartridges be utilized? What is the criteria of acceptance for breakthrough from primary to backup cartridge? Specify the acceptance criteria (precision and accuracy) for duplicate cartridges.

   - Will an internal standard be established by the spiking of blank, sample and calibration cartridges? Describe the spiking procedure.

   - Are recovery and precision data available for the selected contaminants to establish the validity of quantitative data? Present all such data and all numerical criteria for quality control purposes.

8. In general, the proposal for ambient monitoring of air toxics must establish the scientific legitimacy of the sampling. Inadequately documented sampling and analytical procedures may necessitate discarding the resulting data.

9. The data package submitted should include, along with the raw data, all the information necessary to perform data validation, including standards preparation, calibration curves, all calculations used for the determination of detection limits and acceptance criteria to be applied (including precision and accuracy limits).

ATTACHMENT B

STANDARD OPERATING PROCEDURES (SOPs)

Standard Operating Procedures (SOPs) must be prepared for all aspects of sampling, analysis and instrument calibration. An SOP is defined as a complete description of a sample collection, analysis, or other operation whose mechanisms are thoroughly prescribed and which details a commonly accepted method of performing routine or repetitive tasks. Its purpose is to ensure consistency of application of a method and repeatability and comparability of results, regardless of which qualified person is performing the operation.

An SOP for sampling and analysis would include the following information:

- method testing, including ruggedness testing
- configuration and maintenance of sampling equipment
- calibration of sampling equipment
- cleaning and demonstration of cleanliness of sampling equipment
- chain-of-custody
- sample collection, including quality control samples such as blanks, duplicates, backups, etc.
- sample handling/preservation/storage
- configuration and maintenance of analytical equipment
- tuning and calibration of analytical equipment
- cleaning and demonstration of cleanliness of analytical equipment
- standards preparation and control
- sample preparation
- spiking
- introduction of samples
- data reduction, processing (including uncertainty analysis), handling, storage and retrieval
- data validation
- reporting of results, including quality parameters
- retention of samples and data
- recordkeeping

A calibration SOP would include:

- a definition of terms used in the procedure
- a description of the specific equipment to which the procedure is applicable, including model number and specifications
- a brief description of the scope, principle and/or theory of the calibration method
- fundamental calibration specifications, such as environmental conditions, calibration points and tolerances

- a description of standards required to perform an effective calibration, including source, identifying serial number, specified tolerance and expiration date
- a list of equipment necessary to perform a calibration, including manufacturer, model number, specified accuracy and maintenance status
- a cautionary list of possible impediments to a successful calibration, such as common procedural errors or interferences
- a clear, concise step-by-step breakdown of the calibration operation from the beginning to end
- specific instructions for recording and reporting the calibration data and its use in qualifying the resultant experimental data.

NAVY RESPONSES TO CTDEP COMMENTS (JANUARY 13, 1993) DRAFT PHASE II REMEDIAL INVESTIGATION WORK PLAN (NOVEMBER 1992)

GENERAL COMMENTS

1. Soil samples were obtained and analyzed from an active Pistol Range located adjacent to the Area A Downstream site in 1990. It is our understanding that these soil samples were obtained because the NSB-NLON was contemplating construction of a parking lot on top of the firing range. Based on the elevated concentrations of lead detected in the soil from the Toxicity Characteristic Leachate Procedure (TCLP), any excavated soil from this site would be classified as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). This area must be further evaluated within the proposed Phase II Area A Downstream investigation to determine if ground water is being impacted from the high concentrations of lead detected in the soil. At a minimum, this would involve installation of upgradient and downgradient monitoring wells in order to analyze the ground water for Target Analyte List (TAL) inorganics, specifically lead.

   Evaluation at the Pistol Range under CERCLA is currently under negotiation as part of the FAA between EPA, CTDEP, and the Navy. The Navy will comply with the final FAA.

2. A question was brought up at the last joint Technical Review Committee (TRC)/Public Meeting held in December 1992 asking if the State Department of Health Services (DOHS) maintained a database containing exposure limits (risk reference does (RfDs) and/or carcinogenic potency factors (CPFs)) for compounds that were more or less restrictive than federal or other recognized industry limits. The DOHS Division of Environmental Epidemiology and Occupational Health was contacted following the meeting and indicated that they do not maintain a database with exposure limits different from that obtained from standard sources.

   However, DOHS does compile Health Risk Determinations in response to requests for evaluating potential drinking and cooking and/or bathing and showering risks from the use of polluted wells. As established under Section 22a-471 of the Connecticut General Statutes, Health Risk Determinations are used in establishing action levels and are applicable to all private water supplies where there are no established standards.

   We appreciate your checking on this point and your response is noted.

3. It is recommended that Sections 7.0 and 8.0 of the Phase II Remedial Investigation work plan be combined with the Field Sampling Plan and QA/QC work plan, respectively. It appears that most of the information contained in these sections is duplicated in the Field Sampling Plan and QA/QC work plans.

We agree that these sections are somewhat repetitive, however, as we discussed, this is necessary if EPA guidance is to be followed.

4. Appendix C contains a memo from Menzie-Cura & Associates, Inc. to Atlantic Environmental Services, Inc. The memo describes the potential target remediation levels for contaminated soils for the following contaminants: polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), DDTR and lead. These target levels were developed based on calculations derived from the risk assessment conducted as part of the remedial investigation/feasibility study (RI/FS). It is important to include within this work plan and the feasibility study all calculations used to determine each cleanup level. These calculated cleanup levels need to be documented and compared to federal and state Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs) as these may require more stringent cleanup standards.

   Additional documentation (calculations) will be provided on the derivation of the preliminary target remediation levels.

   This section will also be revised to show the values of chemical-specific ARARs and TBCs.

5. Section 5.3.4 (Characterization of the Estuarine Environment of the Thames River) of the Phase II Remedial Investigation work plan describes the tasks that will be conducted under the ecological study to characterize the Thames River in the vicinity of the NSB-NLON. It would be of benefit to include a map or figure identifying the commercial shellfisheries along the Thames River to the north and south of the NSB-NLON. It is our understanding that the member towns on the TRC committee maintain this information.

   The shell fisheries will be more clearly shown in the figure provided.

6. It is recommended that the contaminants or compounds of potential concern for those sites where soil and/or ground water contamination has been detected be contoured and plotted on site maps. This task could be either incorporated within this work plan or added after completion of the Phase II investigation. This information will aid in visualizing the nature and extent of contamination for each site and assist in remedial efforts during the feasibility study.

   Concentrations of chemicals of concern will be plotted or contoured on site maps after implementation of the Phase II work plan field work.

7. Performance of a base-wide measurement and contouring of ground water elevations from monitoring wells at the NSB-NLON was requested by EPA and agreed to by the Navy and DEP several months ago. It was decided that the water table measurements should be conducted within a very short time-frame to avoid errors from using existing seasonal data. No task has been incorporated within these work plans to accomplish this

requirement. Please clarify if this task will be accomplished within the framework of these investigations.

A task will be added to the work plan to produce a basewide ground water elevation map.

8. All analytical results to date for boron that has been detected in surface and ground waters should be flagged and footnoted within this report. The footnote should indicate that the analytical results for boron may be inaccurate due to lab error.

The work plan will be revised to indicate that Phase I RI boron data is probably erroneous due to sulfur interference.

DRAFT WORK PLAN PHASE II REMEDIAL INVESTIGATION COMMENTS

9. <u>Page 16, Supplemental Step I Investigation</u>

Include an explanation within this section as to why Supplemental Step I investigations are not being conducted as part of this work plan for the CBU Drum Storage Area and the Over Bank Disposal Area Northeast (OBDANE) sites.

The investigation work plans for these two sites are presently being prepared. It is our intention to include these in the final work plan. The draft work plan for these sites will be submitted for review when completed. They were not included in this version of the work plan as a contract modification could not be completed in time to allow their inclusion.

10. <u>Page 23, Nature and Extent of Contamination</u>

The second paragraph should note that 1,1-dichloroethene was detected at 1 ppb and that 1,1-dichloroethane was detected at 30 ppb for the Torpedo Shops site.

This paragraph will be revised as noted.

11. <u>Page 25, Goss Cove Landfill</u>

Define the saturated thickness and perpendicular cross sectional length used in calculating the ground water flow velocity at the Goss Cove Landfill. This data was supplied for the DRMO site on page 47 and for the Lower Subase site on page 51.

This information will be provided. The saturated thickness was estimated to be 50 feet and the perpendicular cross-sectional area was estimated to be 50 feet x 230 feet for a total of 11,500 square feet.

12. **<u>Page 33, Weapons Center</u>**

It is unclear where Building 524 is located. Please depict its location on Figure 2-12.

Due to the scale of Figure 2-12, Building 524 cannot be shown in this figure. It will be added to Plate 1 and the text will be revised accordingly.

13. **<u>Page 43, Residential Well Analytical Results</u>**

The top paragraph on this page noted that boron was found in all residential wells above the U.S. EPA health advisory of 600 ppb. This paragraph should be revised to reflect the following information: 1) that the validity of the initial three rounds of sampling data analyzed by N.E.T. Atlantic was found to be unreliable due to lab error, 2) that supplemental sampling conducted by the Navy and DEP in August 1992 found boron levels well below the U.S. EPA health advisory, and 3) that a separate draft Plan of Action and/or Field Sampling Plan to further evaluate boron will be contingent on whether future sampling of residential homes surrounding the NSB-NLON confirms previous analytical data.

The paragraph will be revised as indicated.

14. **<u>Page 119, Rubble Fill at Bunker A-86</u>**

Methoxychlor at 370 ppb in the soil exceeds the State Drinking Water Standard of 100 ppb. Therefore, it is not correct to state that no chemical-specific ARAR/TBC values were exceeded during the Step I investigation performed at this site. The DEP guidance for soil cleanup would apply as a TBC value for this site.

As we discussed, CTDEP written policy pertains only to VOCs and metals. However, based on our discussion and your explanation that unwritten CTDEP policy applies whenever an action level has been adopted, this section will be revised as suggested in your comment.

15. **<u>Page 120, Table 6-2</u>**

It is noted that chemical-specific ARAR/TBC values exceeded during the Step I investigations are presented in Table 6-2. Boron should be flagged in this table and elsewhere due to the possibility of erroneous lab data.

We agree and will make this revision.

16. **<u>Page 128, Risk Assessment</u>**

It is noted in the second sentence on the top of page 128 of the Human Health Risk Assessment section that no potable water supply wells exist in the potentially affected downgradient areas for the Area A site. It is premature to note this until monitoring well data is obtained southeast of the Area A Landfill. Should ground water be found to be migrating in a southeasterly direction, several residential wells could be affected downgradient of this site. This statement should be clarified.

We agree with your comment and will revise this paragraph as suggested.

17. **Page 3, References**

Reference to "U.S. EPA, 1988. Contract Laboratory Program Statement of Work for Inorganics Analysis. 7/88." should be noted only once.

The duplicate reference will be eliminated.

18. **Page 2, Appendix C**

In developing a maximum target cleanup level for PCBs in surface soils, Menzie-Cura & Associates, Inc. selected a level of 10 mg/kg. It was incorrectly noted that this level is consistent with levels that have been used in Connecticut and other states to guide remediation efforts. It should be noted that 10 mg/kg is consistently applied only at GB classified areas in Connecticut. The NSB-NLON is located in a GA classified area and PCB cleanup in GA areas must attain a level of 2 mg/kg.

The 2 ppm does not appear to be appropriate to these sites which are closed industrial landfills. We realize, however, that this issue can not be resolved at this time and will include the 2 ppm level as a preliminary remediation target level. At some future date when the extent of contamination has been better defined, we would like to further discuss the appropriateness of this standard in light of the feasibility of remediation to this level.

DRAFT FIELD SAMPLING PLAN, QA/QC PLAN AND HEALTH AND SAFETY PLAN COMMENTS

19. **Page 5, Supplemental Step II Investigations**

The last sentence in the second paragraph should be revised to note that the investigation for determining the source of boron may not be conducted. The investigation will be dependent on the results obtained from the first quarterly round of sampling proposed for the residential homes.

This sentence will be revised per your comment.

20. **Page 16, Sample Headspace Screening for VOCs**

This section noted that data obtained from the screening of soil samples in the field with a photoionization detector or flame ionization detector will not be used "qualitatively". Substitute quantitatively for qualitatively.

This change will be made.

21. **Page 20, Monitoring Well Construction**

    It is unclear how a one gallon per minute or greater flow rate will be determined in the field during bedrock drilling. Please clarify.

    This rate is estimated while drilling by observations of the flow of drilling fluids based on the experience of the driller and Atlantic geologist and confirmed prior to completion of the well by pumping.

22. **Page 25, Rubble Fill at Bunker A-86**

    A test boring will be advanced through the Rubble Fill at Bunker A-86 to evaluate potential surficial contamination as part of the Step II investigation. Although it is not stated, it should be indicated that a visual inspection of the rubble fill will be conducted during the test boring to characterize the contents.

    This paragraph will be revised to indicate that a visual inspection of the rubble fill will be conducted.

23. **Page 32, Table 4-9**

    It appears that the location of the deep monitoring well 7MW2D is depicted on Figure 4-4 as sidegradient of the north leachfield system, rather than downgradient (see Table 4-9). Monitoring well 7MW2D should be depicted and installed downgradient of the existing monitoring well 7MW2S in order to monitor the quality of ground water downgradient of the leachfield. In addition, monitoring well 7MW3D should be moved further west of its presently depicted location on Figure 4-4 in order to characterize ground water downgradient of the south leachfield system.

    We agree and the well locations will be depicted in the locations indicated.

24. **Page 32, Table 4-9**

    Based on data contained in the Goldberg-Zoino & Associates, Inc. (GZA) report located in Appendix A, mineral spirits up to 11,000 mg/kg were detected in the area around the waste Otto fuel sump and tank. Total petroleum hydrocarbon (TPH) analysis must be included along with the other proposed analysis for those test borings and wells installed near the former underground Otto fuel tank. In addition, it should be noted within this section whether any visible contamination was evident and samples taken from the tank grave during closure of this tank.

    TPH will be added to the list of parameters in samples collected to characterize the Otto fuel area at locations 7MW5S, 7MW5D, 7TB11, 7TB12, 7TB13, and any necessary supplemental borings.

25. **Page 30, Torpedo Shops**

It is noted on this page that a soil gas survey will be conducted at specified grid points in areas surrounding the Torpedo Shop buildings and storage areas. It is advised that methane be analyzed as well as volatile organic compounds (VOCs) during the soil gas survey. The October 1989 analytical results from the GZA report revealed that methane was detected in the auger cuttings for GZ-1 and GZ-3 up to 9.5 ppm adjacent to Building 450. It is not clear where and/or why the methane is being generated, but screening is recommended due to the proximity of the buildings.

As we discussed, the 9.5 ppm of methane is neither indicative of a significant source of methane or near levels of concern regarding toxicity or flammability. In addition, there is no indication that organic wastes have been disposed at this location. For these reasons, we do not propose to analyze for methane during the soil gas survey at this site.

26. **Page 34, Figure 4-4**

It does not appear that surface water sample location 7SW1 is depicted on Figure 4-4. Please correct.

It is shown, however, as an existing sample location and its symbol should be changed to indicate it is a proposed sample location.

27. **Page 38, Table 4-11**

It is recommended that methane monitoring be conducted in addition to the proposed air sampling for VOCs within and around the Nautilus Museum Building. Monitoring of methane is also recommended during installation of monitoring wells 8MW6S&D due to proximity to the museum.

The work plan will be revised to provide for methane monitoring in soil gas around the building and during the installation of 8MW6S and 8MW6D.

28. **Page 57, Area A Landfill**

It is noted that detection of PCB concentrations at or above 10 ppm in any or all of the borings drilled within or around the concrete pad will prompt the initiation of supplemental boring(s) to better delineate the outermost extent of contamination. State cleanup levels for PCB-contaminated soils to 10 ppm is consistently applied only to areas with a GB ground water classification. The NSB-NLON is located in an area with a ground water classification of GB/GA or GA. DEP will require that PCB-contaminated soils be remediated to 2 ppm at the NSB-NLON. In addition, core samples should be obtained from the concrete pad to determine whether PCBs are leaching from the pad into the subsurface and potentially contributing to ground water contamination.

See Comment 18. The plan will also be revised to obtain and analyze core samples from *the concrete pad for PCB. Four samples will either be collected from oil stained areas of the pad or randomly if no such areas are evident.*

29. **Page 58, Area A Landfill**

It is noted that bedrock monitoring wells 2WMW21D, 2LMW20D, 2LMW19D and 2DMW23D will be installed to a minimum open hole depth of approximately 100 feet below the surface of the bedrock. This depth was chosen so that ground water samples collected from these wells would be representative of, and comparable to, those collected from residential wells located off the NSB-NLON. It is recommended that continuous packer testing and sampling at a specified interval be conducted for one or more of the proposed deep monitoring wells to identify high yielding water bearing zones and any potential contamination. The selected deep bedrock well(s) should then be screened at the appropriate depth based on highest yields. The residential wells located off the NSB-NLON are most likely not screened, thus it would be more reasonable to screen at those intervals where the highest yields are obtained within the bedrock as this will be representative of the primary source of water to the residential wells.

Both EPA and CTDEP commented on the bedrock well design. EPA suggested to drill the bedrock wells to the depth at which they are capable of providing a yield greater than 1 gpm and stated that the objective of simulating water withdrawal is not appropriate. CTDEP suggested that continuous packer tests be performed in one or two wells and that well screens be set in the highest water yielding zone. CTDEP also stated that the zones of highest yields will be representative of the primary source of water to residential wells. During our phone conference, EPA felt after discussion, that the CTDEP packer testing approach was preferable. Packer testing would be capable of defining the highest yield zone in a well, however, whether or not this is the most appropriate zone to sample bears some discussion. The highest yielding zone may not be the most contaminated zone or contaminated at all. Sampling every zone is not feasible and will not substantially add to our understanding of the site. We disagree with EPA that the objective of simulating well water withdrawal does not appear to be appropriate. Remediation standard for this area will be based on MCLs which are measured at the tap, no in situ. We feel the objectives of these wells should be to simulate residential wells and detect contamination. Packer testing and screening at the highest yielding zone may not detect contamination in low yielding zones. Drilling to the first water bearing zone could result in the non-detection of contaminants in deeper zones. The effects of dilution of any particular water bearing zone in a deep well must be evaluated regarding contaminant detection. In a hypothetical 100-foot deep bedrock well containing ten different zones, one yielding 1.0 gpm and the others yielding 0.1 gpm, dilution factors are 1.9 to 1 for contaminants in the high yield zone and 19 to 1 for each of the low yielding zones. With this in mind and after consideration of EPA and CTDEP comments, the design in the work plan seems preferable to either alternative as it will detect any significant contamination and it accurately simulates a residential well for comparison to MCLs.

30. <u>Page 58, Area A Landfill</u>

The first paragraph on this page indicates that select residential wells will be "measured" twice. This seems inconsistent with proposals to sample and measure water tables of offsite residential homes on a quarterly basis for a period of one year. Please clarify.

As we discussed, we are limiting the collection of water level measurements to twice due to the difficulty in obtaining these measurements. Quarterly water samples will be taken at the same time water levels are measured.

31. <u>Page 58, Area A Landfill</u>

It is noted that the pump well proposed within the northwest section of the Area A Landfill site will be screened approximately 40 feet throughout the entire saturated thickness of the overburden aquifer. It should be explained where the four proposed observation wells will be located and whether they will also be screened the full length to measure average hydraulic heads in the overburden.

Additional detail regarding the pump test, including observation well location and screening, will be added to the work plan.

32. <u>Page 58, Area A Wetland</u>

The section covering the Area A wetland should note that proposed sediment sample locations are depicted on Figure 4-7, not Figure 4-8.

The figure reference will be changed to Figure 4-7.

33. <u>Page 59, Area A Wetland</u>

It is noted that the deep bedrock monitoring well 2WMW5D will be installed to the depth of the first water bearing zone of fracture concentrations. Explain in this section how the water bearing zone will be determined.

It will be determined as described in our above response to Comment 21.

34. <u>Page 59, Area A Wetland</u>

It may be more reasonable to measure the water table for each Area A Wetland well on a quarterly basis in conjunction with residential wells.

We agree and in our response to EPA comments have proposed to change the frequency of water level measurements to quarterly.

35. **Page 61, Area A Downstream/OBDA**

The third paragraph notes that sediment and surface water samples located at the ground water seeps into North Lake will be sampled and analyzed for TCL parameters. This action is being taken to determine if any upgradient, contaminated ground water may be impacting the lake. With this in mind, it is recommended that a limited soil gas survey and subsurface sampling be performed at monitoring well 2DMW15S. Phase I investigations found TCE, PCE and other compounds at elevated levels within subsurface soils at this location. This area is located just upgradient of North Lake and should be further investigated to define the extent of contamination. The non-detect analytical results of the ground water from this well is not sufficient justification for discontinuing any further characterization at this location.

We will revise the report to provide for a limited soil gas survey in this area. As the depth to bedrock is around four feet in this area, the soil gas survey should be capable of finding any contaminant source areas. If any areas of contamination are detected by the soil gas survey, a soil sample will be collected from any such area and analyzed for VOC.

36. **Page 63, Defense Reutilization and Marketing Office (DRMO)**

Explain the rationale for replacing existing upgradient monitoring wells 6MW5S&D with wells 6MW6S&D at the DRMO site. In addition, test boring 6TB24 should be converted into a monitoring well to analyze ground water in this area. Remediation of this area may be required due to the high soil gas and subsurface soil sample contaminant concentrations detected in this area from the Phase I investigation.

During the Phase I investigation, we did not want to place any wells in the area near 6MW6S and 6MW6D as they probably would be destroyed during the construction activities proposed for this area at that time. There are presently no construction activities proposed for this area and this location is directly upgradient rather than farther upgradient. For these reasons, well 6MW5S and 6MW5D have been replaced by 6MW6S and 6MW6D.

Regarding location 6TB24, a shallow well will be added at this location and sampled for VOC to better define this area.

NAVY RESPONSE TO MR. ROBERT FROMER'S COMMENTS (MARCH 14, 1993) ON THE DRAFT PHASE II REMEDIAL INVESTIGATION WORK PLAN (NOVEMBER 1992)

ROBERT FROMER'S WRITTEN COMMENTS

I have carefully reviewed the referenced memorandum and offer the following comments.

Enclosed with this letter is a copy of an article from the U.S. Environmental Protection Agency's (EPA) Nonpoint Source (NPS) News-Notes of March 1993. The article addresses the issue of groundwater ecology and its relationship to surface water ecology.

The approach used by Atlantic Environmental Services (AES) to the remedial investigation at the Naval Submarine Base - New London, Groton, Connecticut requires expansion to an ecosystem-based holistic approach. The investigation ignores the effects of contamination on the food webs of surface and groundwater. Micro and macroorganisms in ground and surface waters form the basis of the food web and determine water quality.

The study needs to assess the diversity and activity of biologics in the connected water bodies after a determination of their flora and fauna.

Ambient water quality criteria of the EPA and Connecticut Department of Environmental Protection incorporate biological factors as a component of water quality determinations. These factors are not reflected in AES's investigation.

Additionally, the entire thrust of the investigation is towards health risks to humans which is contrary to EPA's groundwater strategy and recommendations of EPA's Science Advisory Board: "The value of natural ecosystems is not limited to their immediate utility to humans. They have an intrinsic, moral value that must be measured in its own terms and protected for its own sake." EPA NPS News-Notes, p. 6. Therefore, the investigation needs to expand to include risks to other life forms.

I request that AES include as an agenda item for the Technical Review Committee meeting a discussion on expanding the study to include ecological risks.

<u>Response</u>

Mr. Fromer's letter addressed four points:

1. "The approach used by AES to the remedial investigation at the Naval Submarine Base - New London, Groton, Connecticut requires expansion to an ecosystem-based holistic approach."

The approach to ecological risk assessment used in the Phase II Remedial Investigation work plan addresses all the components of the ecosystem.

The first step in an ecological risk assessment is to evaluate the environment being studied and the type of habitat it provides. At the Subase, the habitat types include wetlands, wooded uplands with ponds and streams, and the Thames River. The ecological risk assessment then proceeds to field work to identify the components of this environment, i.e., the species of flora and fauna that are observed at the site or that may be expected to occur there based on habitat type. These observations were performed for the Area A wetland and downstream areas as part of the Phase I Remedial Investigation. When these species are identified, their habitat requirements and other characteristics are identified such as feeding preferences, length of time resident on-site, nesting sites, etc. Information such as endangerment status also reviewed. Based on this information, species are chosen for assessment that are important for the region or that represent certain feeding groups that may be effected by contaminants in a similar manner. This step of the process was also performed as part of the Phase I Remedial Investigation for Area A.

Additional identification of ecological components in Area A streams and ponds and in the Thames River will be performed in this work plan. This work plan includes benthic sampling for invertebrates in Area A ponds and streams to identify individual species. Fish will also be collected and identified from Area A if there are any to be found there.

For the Thames River, the work plan included a review of available information on organisms dwelling in the Thames River (Section 5.2.2.4 - Summary of Existing Thames River Data). Under the work plan, a more thorough study of existing information will be made to identify all the components of the Thames River ecosystem. In addition, sampling for benthic organisms will occur to identify species living in Thames River sediment.

2. "The study needs to assess the diversity and activity of biologics in the connected water bodies after a determination of their flora and fauna." This statement refers to an article on groundwater ecology in EPA's Nonpoint Source News-Notes of March 1993.

Micro and macroorganisms live in groundwater. The microorganisms, bacteria, molds, etc. have been well studied. They adapt to groundwater conditions and can live in oxygenated or anoxic conditions. They can also adapt to the presence of contaminants in groundwater and can use organic compounds as a food source. They break them down to smaller compounds and ultimately to methane or carbon dioxide and water.

The macroorganisms in groundwater are less well studied. According to John Simons, the author of the article in the Nonpoint Source News-Notes, the macroorganisms may be important components of the ecosystem in pristine areas where they can move back and forth from groundwater to surface water. Some of these organisms remain in groundwater throughout their life cycles. These organisms are unlikely to be important in disturbed areas, such as the Subase where streams are channelized and the river is bulkheaded. These structures prevent the movement of organisms between groundwater and surface water. Like bacteria, these organisms may be able to degrade organic contaminants in groundwater.

3. "Ambient water quality criteria of the EPA and Connecticut Department of Environmental Protection incorporate biological factors as a component of water quality determinations. These factors are not reflected in AES's investigation."

   The use of Ambient Water Quality Criteria for the protection of aquatic life is an important component of the ecological risk assessment. They were used in the previous work to assess risks to biota in Area A streams and the Thames River. They will also be used in the assessment performed under this work plan. The first step of the ecological effects assessment is to identify criteria to assess toxic effects in fish and wildlife. The values used to assess risks to fish are EPA and/or Connecticut DEP ambient water quality criteria. These criteria are also used to assess risks to benthic organisms from contaminants in sediment pore water via the equilibrium partitioning approach.

4. "Additionally, the entire thrust of the investigation is towards health risks to humans which is contrary to EPA's groundwater strategy and recommendations of EPA's Science Advisory Board..."

   Section 4.0 of the work plan addresses human health risks. Section 5.0, Ecological Risk Assessment Work Plan, addresses only risks to the ecosystem such as fish and wildlife receptors.

In closing, a detailed presentation on the proposed human health and ecological assessment was made at the May 5, 1993 TRC meeting.

NAVY RESPONSES TO CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION'S COMMENTS (March 24, 1993) ON CBU AND OBDANE SECTIONS (March 1, 1993) OF THE PHASE II REMEDIAL INVESTIGATION: WORK PLAN, FIELD SAMPLING PLAN, QA/QC PLAN, AND HEALTH AND SAFETY PLAN

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1. <u>Page 196, Section 10 of the Phase II Remedial Investigation Draft Work Plan</u> - The schedule outlined within this section will have to be revised to incorporate the Supplemental Step I investigations proposed for the CBU Drum Storage Area and OBDANE sites.

   This schedule has been revised to show CBU and OBDANE. The revised schedule is in the March 1993 draft of the Work Plan, Phase II Remedial Investigation.

2. <u>Section 7.1.1 CBU Drum Storage Area</u>

   A. Table 7-3 must include provisions for total petroleum hydrocarbon (TPH) analysis along with the other proposed parameters. Analytical results from the Phase I RI performed at this site detected TPH in the three soil sample locations ranging from 110 to 9800 ppm. The TPH analytical method is appropriate considering that waste oils and lube oils were stored at this site. TPH analysis is necessary in determining the horizontal and vertical extent of petroleum contamination.

   Total petroleum hydrocarbon (TPH) analysis will be specified for all samples listed in Table 7-3 (6 soil and 2 water).

   B. It should be reiterated that DEP requires remedial action at sites where it is found that the sum of all hydrocarbons in the soil exceed 100 ppm. This requirement is applicable at the NSBNL because it is located in an area with a groundwater classification of GA and GB/GA. As such, DEP will require that the NSBNL sample for TPH at all sites where it is determined that petroleum contamination is present.

   Is it your position that the 100 ppm you advocated is an ARAR for this site? That is, it is an applicable or relevant and appropriate requirement under Section 121 (d) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), 42 USC 9601 et. Req. If that is your position, please provide specific legal citation(s) to promulgated state law(s) or regulation(s) that support the standard.

   In addition, please explain why each cited requirement is an ARAR at the site. This explanation should include one of two alternative positions. It should *explain how the requirement(s) specifically address a hazardous substance, pollutant, contaminant, or other circumstances under CERCLA. Or, in the alternative it should explain how the requirement(s) address problems or situations sufficiently similar to those at the site that their use is well suited to the site.*

NAVY RESPONSES TO U.S. EPA COMMENTS (APRIL 15, 1993) ON CBU AND OBDANE SECTIONS (MARCH 1, 1993) OF THE PHASE II REMEDIAL INVESTIGATION (WORK PLAN, FIELD SAMPLING PLAN, QA/QC PLAN AND HEALTH AND SAFETY PLAN)

GENERAL COMMENTS

1. This document was difficult to review since it did not specifically make reference to the particular sampling protocol or any other section(s) of the Phase II RI project plans for sampling procedures, sample preservation, holding times, chain of custody/shipping of samples, frequency of QA/QC sample collections and associated criteria, analytical methods and procedures, data validation, or for distribution of project reports. The text should, at a minimum, reference the applicable sections in the Final Phase II RI Work Plan.

   The draft Phase II RI Work Plan has been revised to include the CBU and OBDANE sites. This revised draft (March 1993) has been submitted to your office for review.

2. Air monitoring should be conducted during <u>all</u> invasive investigation procedures to ensure worker protection. In addition, the work plan should include a statement regarding the airborne contaminant concentration action levels at which protective equipment must be donned (i.e., limits beyond which field work ceases until protective equipment can be donned).

   The portion of the Phase II Work Plan which discusses issues relating to air monitoring for VOCs (i.e., worker safety and fenceline measurements for migration of contaminants off-site) is also relevant to these two sections.

   Consideration should be given to monitoring for semi-volatiles related to fugitive dust during significant invasive procedures. This becomes especially important during the remediation phase.

   The Phase II RI Health and Safety Plan does specify air monitoring requirements and appropriate levels of personal protection equipment to be used by workers based on air monitoring results. OBDANE and CBU are included in the Phase II Health and Safety Plan, therefore health and safety procedures, and air monitoring procedures have been specified for CBU and OBDANE.

   As stated in our previous response to a similar question regarding the Phase II Work Plan as it pertains to other sites we agree that air monitoring for semi-volatile constituents during any remediation activities as part of a health and safety plan, may be warranted and will be considered at that time.

3. As discussed in EPA's May 20, 1992 letter regarding the Navy's responses to EPA's comments on the draft August 1991 Installation Restoration (IR) Report, there is some concern that the scope of the Step I investigations may not be sufficient to completely characterize the nature and extent of contamination at these areas. Given the number of years that have transpired since the time that many of the documented releases occurred, it is possible that contamination has migrated outside the original site boundary. EPA requests, therefore, that the Navy consider the installation of a downgradient monitoring well at each site to ensure that the ground monitoring system adequately assesses groundwater quality at the base.

We did consider a scenario of installing up- and down-gradient wells at this site. Based on the objectives of this supplemental Step I investigation it appeared that these wells were not necessary. The purpose of these supplemental Step I investigation is to determine if the low levels of contaminants detected in soil have had a measurable impact on groundwater. As such the one well in the center of the source area we believe is adequate to make this determination.

4. Regarding the compositing of samples in earlier investigations, EPA Region I ecological risk assessment requires the use of individual analysis. Future soil samples must be analyzed separately to rule out any dilution effects which could occur with compositing.

No sample compositing has been proposed in either the CBU or OBDANE Work Plans.

SPECIFIC COMMENTS

1. **<u>Section 2.2 — Supplemental Step I Investigations</u>**

The text states in the last sentence that the information is summarized from information that is presented in more detail in the Phase I RI Report, and from any additional background information obtained during the preparation of this work plan. Please identify the additional background information and indicate by reference notation where they are used in the preparation of this work plan.

The additional background information referenced in this section consists primarily of a site inspection performed on February 23, 1993 and a review of the Site Analysis, U.S. EPA Environmental Monitoring Systems Laboratory, March 1992. These sources will be added to this section.

2. **<u>Section 5.2.2.1.1 — Site Background</u>**

The last sentence of the first paragraph of this section states (with reference to Figure 2-6) that runoff does not flow to the nearby catch basin, but there is no indication of a catch basin near the storage area depicted in Figure 2-6. Please clarify the location of the catch basin in the figure.

The last paragraph of this section states that the drums noted in the IAS report were removed. Please indicate when the drums were removed. Also, please provide information as to when the two drums noted on October 20, 1988 were placed in the storage area and when they were removed.

The last sentence of the last paragraph states that not drums were observed on-site "nor was there any evidence of recent storage or leakage of drums". Please explain how the "evidence" was determined. For example, was it based on simple visual site inspection(s), or were field surveys made with detection instruments at surface and subsurface locations, or were other approaches used?

The catch basin is shown but not labeled in Figure 2-6. It is located at the southern end of the storm sewer which transects the deployed parking area. The drums were removed shortly after the IAS inspection. The two drums noted during the 1989 inspection were removed in 1989. This information will be included in the Work Plan.

The "evidence" was based on a visual examination. This will be clarified in the test.

3. <u>**Section 5.2.1.3 — Nature and Extent of Contamination**</u>

The text describes contamination detected at the site as resulting from previous activities conducted at the site. Please identify references for the data presented in this section.

The previous activity referred to is use of this area for storage of drums as documented during the IAS (1982) Atlantic (1988) inspection, and U.S. EPA aerial photograph site analysis (1992). These sources will be referenced in this section.

4. <u>**Section 5.2.2.2.1 — Site Background**</u>

The last paragraph of this section states that Atlantic personnel inspected the site on September 30, 1988 and on February 23, 1993 and verified the presence of several empty drums. Please provide more details as to the type of drums (steel, fiberboard, etc.), and their condition, i.e., intact, ruptured, open, crushed, or other. Also, please clarify how the drums were verified, i.e., by visual inspection, by radar, by unearthing then, or by other means.

The additional data will be provided and the means of verification which was solely based on visual observations will be indicated.

5. <u>**Section 5.2.2.2.2 — Site-Specific Geology and Hydrology**</u>

The second and third paragraphs make reference to the "fill material" at the site. Please elaborate on the description of this material.

The description will be modified based upon Atlantic's visual observation. The fill appears to consist primarily of soil and construction rubble.

6. **<u>Section 5.4.1 — Replacement Paragraph 2</u>**

The fifth sentence does not fully address ecological concerns with regard to soil. Because of the lack of soil criteria regarding ecological concerns, exposure calculations will be required so that a comparison can be made to available literature information. It is suggested that the sentence be modified to read:

"The assessment will be based on a comparison of contaminant concentrations to health-based ARARs for groundwater and soil, site-specific background concentrations for inorganics in soil, exposure calculations based on maximum and mean contaminant concentrations in soil, and professional judgement as to potential risk a contaminant may pose at certain concentrations in a particular medium."

The paragraph will be revised as suggested.

7. **<u>Section 5.7.1 — Supplemental Step I Storage Area</u>**

The installation of a single monitoring well may not be sufficient to completely "assess whether contamination has impacted deeper soils and groundwater" at this site. As previously discussed, since earlier studies identified contamination at the site, subsequent investigatory work should be designed to assess the extent, in addition to the nature, of contaminated detected.

Please refer to our response to general comment number 3 above which addresses this issue.

8. **<u>Table 7-3 — CBU Drum Storage Area Field Sampling Plan</u>**

As a point of clarification, the surface soil (0-2') samples should be analyzed individually, not as composites, for inorganics (TAL), and organics, TCL volatiles, semi-volatiles and pesticides.

The work plan does not propose to composite soil samples.

9. **<u>Section 7.1.2 — OBDANE</u>**

The fourth paragraph states, "There were no other compounds identified at the site above background values". As stated in EPA's May 20, 1992 letter, EPA will not accept published values for background levels of inorganics for comparative risk analyses. Site-specific background soil data for inorganics must be collected from each site. Several sections of the revised field sampling still make reference to "published" background levels. Have background samples been collected from this site? Further clarification of this issue is requested.

The Navy has previously agreed to develop site-specific background levels and will use these values in the Phase II Work Plan when they are available. The samples for *background determination were collected in April 1993. Validated results should be available in June of 1993.*

10. **Table 7-6 — OBDANE Field Sampling Plan**

As a point of clarification, the surface soil (0-2') samples should be analyzed individually, not as composites, for inorganics (TAL), and organics, TCL volatiles and semi-volatiles.

The work plan does not propose to composite soil samples.

11. **Section 4.2.1.1 — CBU Drum Storage Area**

This section describes the collection of subsurface soil samples from each of three test borings. The section needs to describe or reference the equipment that will be used to make these borings including procedures for sampling soil and for associated equipment decontamination. Also, description, or reference to other sections of the work plan, need to be given for sample preparation, preservation, and for laboratory shipment as well as the type and frequency of QA/QC samples that will be collected.

The second paragraph states that borings 1TB1 and 1TB2 will be advanced to a depth of 15 feet. However, all soil borings should be terminated only after a minimum of 15 feet and after 15 feet of soil which is determined to be uncontaminated, based on field instrument screening. This will ensure that the vertical extent of contaminated soils will be determined.

The last sentence of the third paragraph states, "a sample will be collected from either the elevation of groundwater or from any fine-grained soil layer present above the water table." Please clarify: "elevation of groundwater" and provide the rationale for collecting a sample from any fine-grained soil layer.

In addition, the section states that one groundwater monitoring well will be installed at the site to characterize the quality of groundwater at the site. Also, Table 4-3 shows a water sample collected from a well designated as 1GW1S. Please confirm whether this is the groundwater monitoring well and also indicate its presence in Figure 4-1. Similarly, groundwater sampling well for the OBDANE designated as 14GW1S in Table 4-5, needs to be indicated in Figure 4-2.

A revised draft Phase II Work Plan which includes CBU and OBDANE has been submitted to EPA. Sampling equipment, procedures, QA/QC and health and safety procedures are specified in this document.

We agree that the borings should be advanced below any evidence of contamination; however, we believe an interval less than 15 feet will be capable of meeting this objective. We, therefore, propose to revise the plan to provide for borings to be advanced to a minimum of 4 feet below any evidence of contamination.

Elevation of groundwater refers to the depth of the apparent groundwater phreatic surface based on an observation of the measured depth to groundwater and degree of soil moisture. This clarification will be made. The rationale for collecting samples from a fine-grained soil layer is that contaminants might accumulate at any such layer present. This criteria was added based on previous EPA comments.

Groundwater samples 1GW1S and 14GW1S will be collected at sample locations 1MW1S and 14MW1S as indicated in tables 4-3 and 4-5. Both monitoring wells 1MW1S and 14MW1S are shown in the appropriate figures.

12. <u>**Table 4-2 — CBU Drum Storage Unit**</u>

Since drums have been stored at this site and given their persistence and lack of mobility in soil, PCBs should be retained as an analyte of interest.

We excluded PCB as they were not detected during previous investigation; however, we will revise the Work Plan to provide for PCB analyses at the CBU drum storage area (6 soil, 2 groundwater).

13. <u>**Section 4.2.1.2 — OBDANE**</u>

Two sediment/surface water samples should be obtained from the drainage at the foot of the hill below of the OBDANE. Analytes should include full TCL/TAL.

The drainage from OBDANE flows to a low spot below the 50-foot contour interval not directly into the stream that flows out of the pond. Surface water has not been observed in this low spot. Both the pond and stream have been previously sampled. As surface water is not present at this low spot and as the stream and pond have been previously sampled, we do not propose to add any additional surface water sampling at this location. The Work Plan will be revised to obtain a sediment sample from the low spot with analyses consistent with all other samples at this site (i.e., TCL, VOC and SVOC, and TAL constituents).

WORK PLAN

PHASE II REMEDIAL INVESTIGATION

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

Prepared For:

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PENNSYLVANIA

Prepared By:

ATLANTIC ENVIRONMENTAL SERVICES, INC.
COLCHESTER, CONNECTICUT

ATLANTIC PROJECT NO.: 1256-18
NAVY CONTRACT NO.: N62472-88-C-1294
AMENDMENT NO.: P00018

MAY 1993

ATLANTIC

ENVIRONMENTAL SERVICES, INC. 188 NORWICH AVENUE COLCHESTER, CONNECTICUT 06415 (203) 537-0751

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1.0 INTRODUCTION

This Work Plan has been prepared to summarize the activities planned for the Phase II Remedial Investigation (Phase II RI) at the Naval Submarine Base - New London (NSB-NLON) in Groton, Connecticut. A Phase I Remedial Investigation (Phase I RI) dated August 1992 summarizes the work completed at NSB-NLON to date. Documents which support this Work Plan are as follows:

- Field Sampling Plan
- Health and Safety Plan
- Quality Assurance/Quality Control and Data Management Plan

NSB-NLON was placed on the National Priorities List (NPL) on August 28, 1991 by the U.S. Environmental Protection Agency (U.S. EPA) pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. This Work Plan outlines a program which will be implemented in accordance with the requirements of CERCLA, the National Contingency Plan (NCP), 40 CFR part 300 (and any amendments thereto), and all applicable U.S. EPA guidance documents, including the U.S. EPA document entitled *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, October 1988.

NSB-NLON consists of approximately 547 acres of land and associated buildings in southeastern Connecticut, in the towns of Ledyard and Groton. NSB-NLON is situated on the east bank of the Thames River, approximately 6 miles north of Long Island Sound. Figures 1-1 and 1-2 show the site vicinity and the site location, respectively. The Subase was established as an official Navy yard in July 1886. The site initially moored small craft and obsolete warships and was used as a coaling station for the Atlantic Fleet. The property was officially established as a permanent submarine base in 1916. The overall base facilities were expanded and a Submarine School training facility was established in 1917; the Submarine Medical Center was established in 1918. During World Wars I and II, the Subase greatly expanded in size and in the number of buildings to support the submarine fleet.

The Subase currently provides a base command for naval submarine fleet activities in the Atlantic Ocean. In addition, the Subase contains naval housing, submarine training facilities, military offices, medical facilities, and facilities for the maintenance, repair, and overhaul of submarines.

Sites included in this Phase II Remedial Investigation are in three different phases of the Installation Restoration (IR) Program. The site locations at NSB-NLON are shown in Figure 1-3. These phases and associated sites are discussed below.

Supplemental Step I Investigations

Two sites are included in this category. These are sites where Step I investigations have been completed. The Step I investigations identified low levels of chemicals which were determined to pose no risk to human health and the environment. However, in response to

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

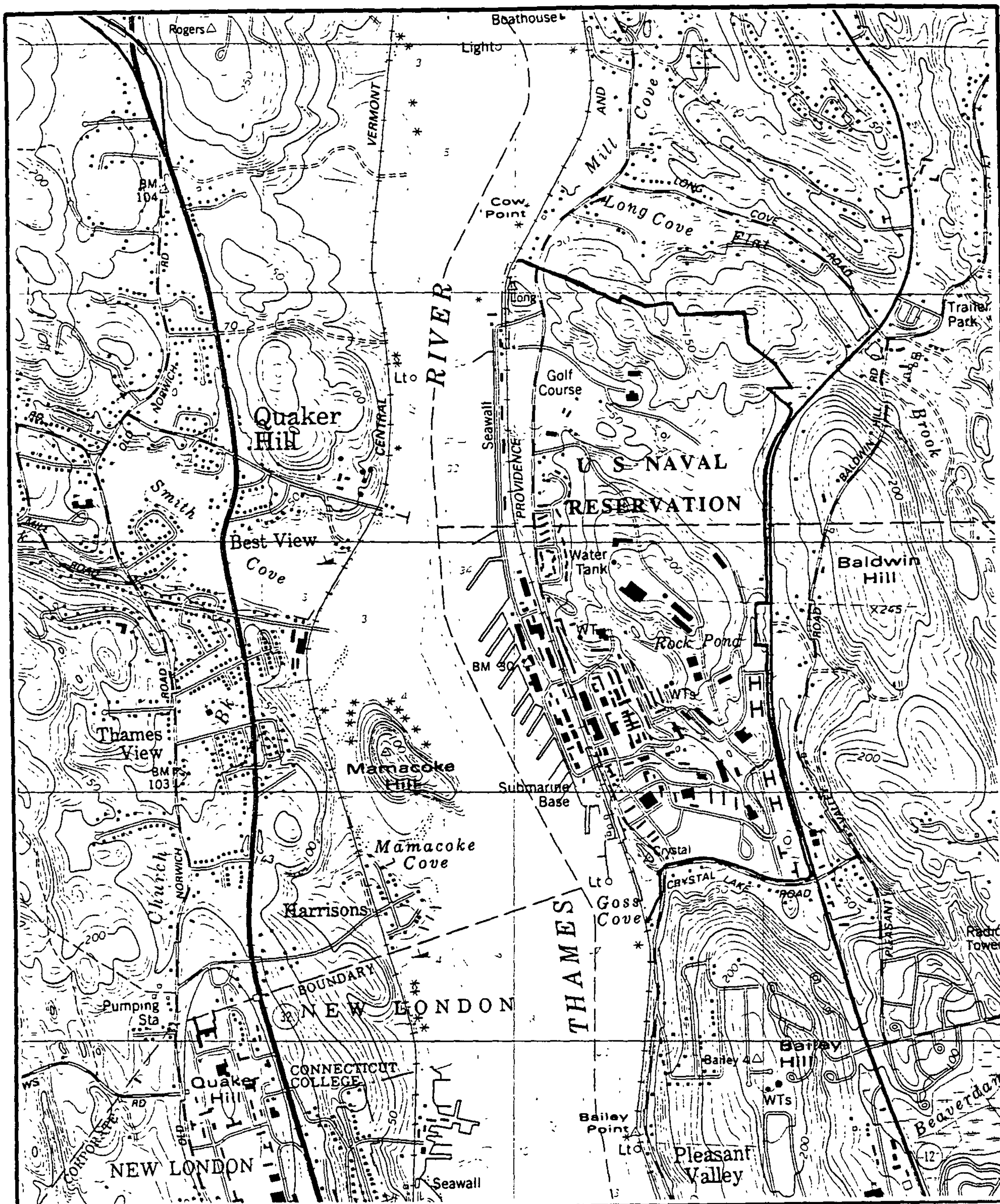
SOURCE: Marshall Penn-York Co. Inc.

Miles
0 1 2 3
APPROXIMATE SCALE

N

FIGURE 1-1
SITE VICINITY

ATLANTIC ENVIRONMENTAL SERVICES, INC.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

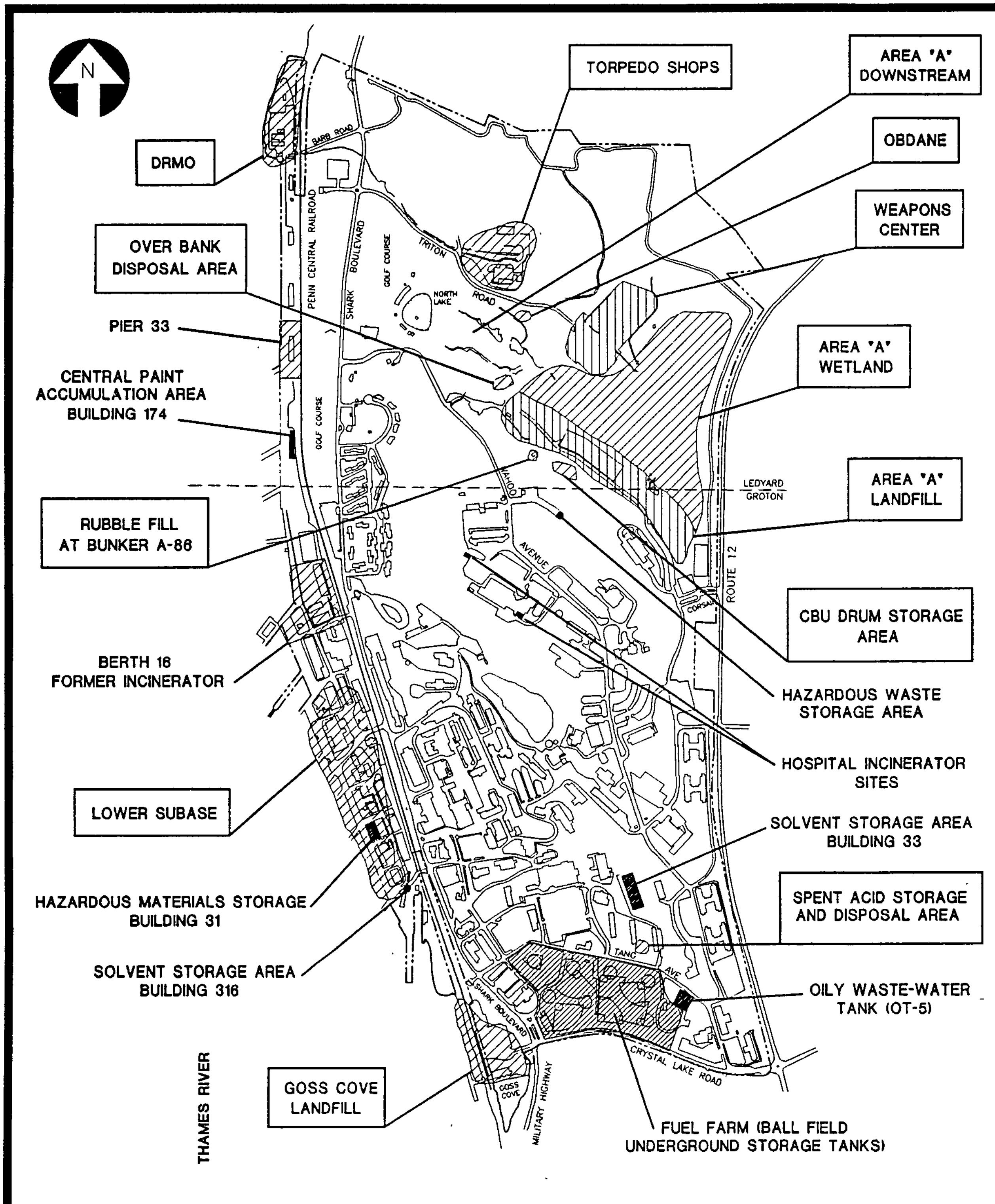
SOURCE: Uncasville, Ct
U.S.G.S. Topographic Map
1984

N

0 1000 2000'
SCALE

FIGURE 1-2
SITE LOCATION

ATLANTIC ENVIRONMENTAL SERVICES, INC.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND GOSS COVE LANDFILL — Phase II RI Workplan Investigation Site SOURCE: Naval Submarine Base, Existing Conditions Loureiro Engineering Associates, April 1985 0 600 1200 GRAPHIC SCALE IN FEET	FIGURE 1-3 INSTALLATION RESTORATION STUDY SITES ATLANTIC ENVIRONMENTAL SERVICES, INC.

comments by the Connecticut Department of Environmental Protection (CTDEP) and the U.S. EPA, supplemental field investigations are being conducted to confirm that chemicals are not present at levels of concern. The sites included for Supplemental Step I Investigations are as follows:

- CBU Drum Storage Area
- Over Bank Disposal Area Northeast (OBDANE)

Step II Investigations

The Step II Investigations involve sites which have undergone an initial (i.e., Step I) field sampling/analysis program in which contamination was determined to be present. Step II investigations include comprehensive site studies designed to determine the nature and extent of contamination, associated health and environmental risk assessment, and feasibility studies to evaluate remedial (cleanup) options. Step II investigations will be conducted at the following sites:

- Rubble Fill at Bunker A-86
- Torpedo Shops
- Goss Cove Landfill
- Spent Acid Storage and Disposal Area

Supplemental Step II Investigations

Supplemental Step II Investigations involve sites that have undergone Step II investigations. However, additional investigations were recommended in the Phase I RI to further define the extent of contamination in certain areas, conduct further health and ecological assessments, and to address comments of the Technical Review Committee. Supplemental investigations will be conducted at the following sites:

- Area A
  - Landfill
  - Wetland
  - Downstream/Over Bank Disposal Area (OBDA)
  - Weapons Center
- Defense Reutilization and Marketing Office (DRMO)
- Lower Subase

The Weapons Center was added for investigation as part of Area A per a recommendation of the Phase I Remedial Investigation (Phase I RI) report.

Two additional sites, Pier 33 and Berth 16/Former Incinerator, have also been added as Step I Sites and are included in a Field Sampling Plan dated July 1992. Furthermore, a separate Work Plan has been prepared to establish background levels for inorganics in soils and to further assess the source of boron in residential wells and in NSB-NLON ground water. However, implementation of the Work Plan with regards to boron is contingent upon results obtained during four rounds of offsite residential well sampling to determine the presence or absence of boron. If boron is not detected in offsite wells above levels of concern, sections of the boron/background work plan regarding boron will not be implemented.

Atlantic's approach to the development of this Work Plan is based on a thorough understanding of the Phase I RI report and associated recommendations, and incorporates all additional data and/or evaluation requirements based on comments from the Technical Review Committee.

In addition to the Phase I RI, all previous background studies and data referenced in the Phase I report were considered in the development of this Work Plan. Where site investigation limits have been expanded (e.g., Torpedo Shops, Area A - Weapons Center), site reconnaissance inspections were conducted and available data reviewed. These data included, but were not limited to, aerial photographs, construction plans, and existing Navy analytical data. This additional background information is provided in the Work Plan where applicable.

The remaining sections of this Work Plan provide the general objectives, procedures and rationale for this Phase II RI. Feasibility Study objectives are also provided for Step II sites. These report sections are briefly summarized below.

Section 2.0 - Evaluation of Existing Data: This section provides background information on NSB-NLON, and site-specific background descriptions of geology, hydrology and the nature and extent of contamination.

Section 3.0 - Site Dynamics: A conceptual model is provided for each site including potential contaminant transport, migration and exposure routes. A brief summary of the potential chemical migration pathways in air, soil and sediment, ground water and surface water are provided.

Section 4.0 - Human Health Risk Assessment: This section provides detailed information on the potential human exposures that will be evaluated in the quantitative risk characterization. It pertains to the Step II and Supplemental Step II sites included in the Phase II RI. Specific details on exposure pathways and methodology are presented for review prior to commencing work. This section describes the steps that will be conducted to complete the risk assessment for the identified sites associated with current and reasonably foreseeable land use.

Section 5.0 - Ecological Risk Assessment: This section provides an overview of the ecological risk assessment work performed to date and the additional work to be completed. The overall objective of the ecological risk assessment is to provide a supplemental qualitative and quantitative assessment of the environmental risks and/or impacts associated with conditions at Area A, and to expand the assessment to study effects of the Subase sites on the Thames River.

Section 6.0 - Preliminary Identification of Remedial Action Objectives and Alternatives: This section provides an overview of ARAR and risk-based standards or criteria, preliminary remedial action objectives and remedial alternative process options. The process is included to ensure that appropriate data requirements are specified for the RI/FS.

Section 7.0 - Remedial Investigation and Feasibility Study Objectives: This section provides site-specific objectives of the Remedial Investigation and Feasibility Study for those sites which have undergone an initial (i.e., Step I) field sampling/analysis program in which contamination was determined to be present. Objectives are also provided for the Supplemental Step II Investigations. The Remedial Investigation will provide data that can be used to determine the nature, extent and degree of contamination at a site, and to identify if a site poses risks to human health or the environment. The Feasibility Study is conducted to develop and evaluate remedial alternatives for site contamination.

Section 8.0 - Data Quality Objectives: This section provides an overview of the requirements for the control of accuracy, precision, and completeness of samples and data from the point of collection through reporting. The organization, objectives, and all QA/QC activities that ensure achievement of desired data quality goals are outlined in the QA/QC Plan.

Section 9.0 - Remedial Investigation/Feasibility Study Tasks: This section defines the tasks established for the Remedial Investigation and Feasibility Study. The tasks described in this Work Plan have been developed to meet RI/FS objectives. This section of the Work Plan follows the standard format outlined in the *RI/FS Guidance* (U.S. EPA 1988a).

Section 10.0 - Schedule: This section outlines the schedule for implementation of RI/FS activities at NSB-NLON.

Section 11.0 - Project Management: This section identifies specific Atlantic personnel who are responsible for implementing various aspects of the project. A project management organizational structure is defined in this section for the investigation at NSB-NLON.

1.1 Purpose and Scope

The purpose and scope of this investigation is specific to each site as presented below in general terms.

Site	Purpose and Scope
CBU and OBDANE	To perform supplemental Step I (Preliminary Assessment/Site Inspection) investigations to determine whether no further action or Step II (RI/FS) investigations are required.
Rubble Fill at Bunker A-86, Torpedo Shops, Goss Cove and Spent Acid Storage and Disposal Area	To perform Step II (RI/FS) investigations to determine the extent and degree of contamination detected during the previous Step I (Preliminary Assessment/Site Inspection) investigations.
Area A/OBDA, DRMO and Lower Subase	To perform supplemental Step II (RI/FS) investigations to fill data gaps from the initial Step II investigation in order to completely define the extent and degree of contamination.

2.0 EVALUATION OF EXISTING DATA

This report section provides current information regarding NSB-NLON, site-specific geology and hydrology, a background description of each site included in the Phase II RI, and a summary of known information regarding the nature and extent of contamination.

2.1 Regional Geology and Hydrology

2.1.1 Bedrock Geology

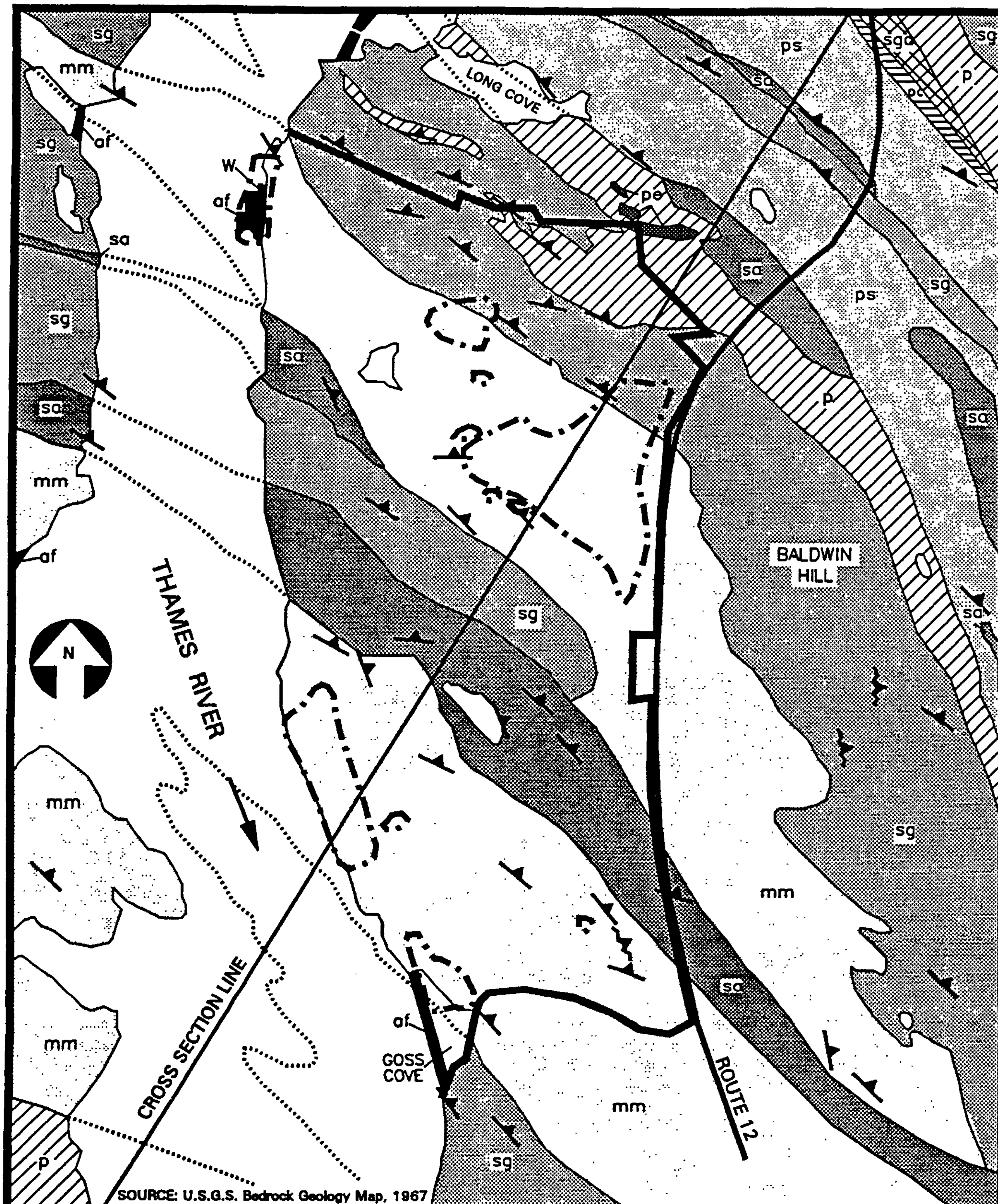
Information regarding the geology of the site and surrounding area is based on data published by the United States Geological Survey (Rodgers 1985) and supplemented by field observations.

NSB-NLON is situated in the Eastern Uplands region of Connecticut, an area that is characterized by irregular hilly areas with many swamps, exposed bedrock, and poorly drained, uneven valleys. The Eastern Uplands can be divided into two geologic terranes according to their origins—the Avalonian Terrane which originated from continental crust, and the Iapetus Terrane, which originated from oceanic crust (Rodgers 1985). The Avalonian Terrane is considered to be the remnant of a relatively small continental land mass that collided with the North American continent in the Late Permian (approximately 250 million years ago). The Iapetus Terrane is composed of sediments from the ocean that lay between the Avalonian continent and the North American continent, which were intensely deformed prior to and during the collision (Bell 1985). The northern portion of eastern Connecticut is part of the Iapetus Terrane. The southeastern portion of eastern Connecticut, including NSB-NLON, consists of intensely deformed rocks that make up the Avalonian Terrane. A major east-west trending fault, the Honey Hill Fault, separates the two terranes approximately six miles north of NSB-NLON. Avalonian rocks, including the bedrock at NSB-NLON, consist of metamorphosed sedimentary and igneous rocks of PreCambrian age.

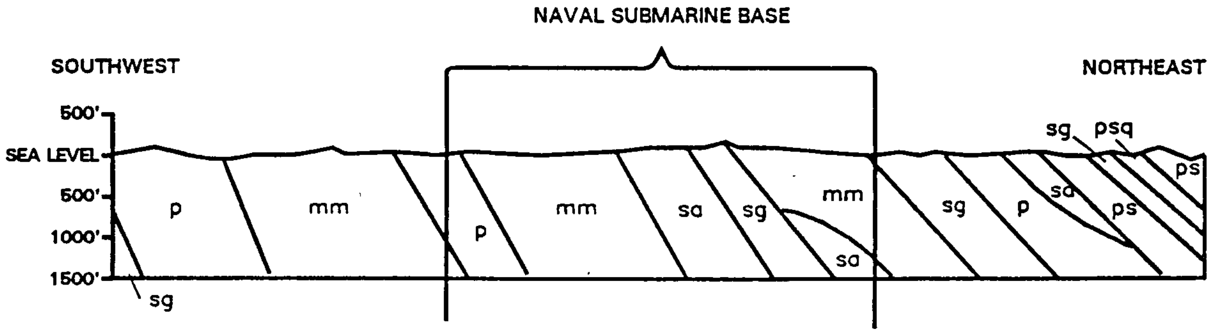
Figure 2-1 shows the bedrock geology and Figure 2-2 presents a generalized geologic cross-section of the NSB-NLON area.

PreCambrian rocks at the site consist primarily of members of the Mamacoke Formation and, to a lesser extent, the Plainfield Formation. Mamacoke Formation rocks are composed of indistinctly layered light-to-dark gray, medium-grained, biotite-quartz-feldspar gneiss. Minor layers contain sillimanite, garnet, hornblende and microline as well. Members are locally granitoid and magmatic. Rocks from a member of the Plainfield Formation underlie the northeast portion of the site. The unit is a dark green hornblende-biotite-quartz-plagioclase gneiss. Members of the Sterling Plutonic Group consist of igneous intrusives that have been metamorphosed to granitic gneisses. The Sterling Plutonic Group is further divided into the Hope Valley Alaskite Gneiss and the Potter Hill Granitic Gneiss.

The Hope Valley Alaskite Gneiss is an orange-pink to light gray, fine- to medium-grained, equigranular, gneissic granite composed of equal amounts of quartz, microline and albitic-to-sodic oligoclase, with small amounts of magnetite and biotite.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND Refer to Figure 2-2 for formation descriptions. - mm - sa - p - ps - pe - sga - sg - af - pc w - Westerly Granite - Sites Investigated Strike & Dip of Mineral Foliation - Inclined - Gently Folded	FIGURE 2-1 BEDROCK GEOLOGY MAP ATLANTIC ENVIRONMENTAL SERVICES, INC.



Cross-section location shown on Figure 2-1

Legend

Alaskite gneiss

sa - orange-pink to light-grey, fine to medium-grained, equigranular gneissic granite composed of about equal amounts of quartz, microcline and albite to sodic oligoclase, and about 1 percent magnetite or as much as 2 percent magnetite and biotite.

Granite gneiss

sg - orange-pink to light-grey, medium-grained, gneissic biotite granite, mainconstituents quartz - microcline oligoclase with 2-7 percent biotite and iron oxides. Locally contains muscovite and garnet; somewhat uneven in mineral distribution. Foliation typically marked by parallelism of alternate flat lenses of quartz and feldspars, and parallelism of biotite flakes. Biotite tends to be concentrated on surfaces between lenses. Some masses have slightly coarser grained streaks rich in orange-pink microcline in finer grained grey quartz-microcline-plagioclase rock. Locally mafic-poor similar to biotitic phases of the alaskite gneiss (sob).

Mamacoke Formation

mm - indistinctly layered light- to dark-grey, biotite-, quartz-feldspar gneissand minor hornblende-biotite-quartz-feldspar gneiss; locally granitoid and migmatic. Thin layers of amphibolite and quartzite. Biotite flakes typically small and mostly evenly distributed.

Plainfield Formation

p - dark-green hornblende-biotite-quartz-plagioclase gneiss, in part diopsidic; dark biotite-quartz-plagioclase gneiss with variable amounts of microcline; garnet-biotite- quartz-feldspar schist and gneiss; amphibolite; light-grey sugary textured biotite- feldspar-quartz gneiss; thin grey quartzite, rare thick white quartzite.

pc - calc-silicate quartzite and gneiss.

pa - garnet-sillimanite-biotite-quartz-feldspar schist and gneiss; garnet- biotite-quartz-feldspar gneiss; biotite-quartz-feldspar gneiss; minor biotite-quartz-andesine gneiss with diopside and colorless amphibole; thin-bedded quartzite, locally pyritic.

psq - thick- to thin-bedded, white or tan, to light-grey, rarely greenishquartzite; thin-bedded micaceous quartzite, locally graphitic; thin interlayers of garnet and sillimanite-bearing schist and gneiss.

INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND SOURCE: U.S.G.S. Bedrock Geology Map, 1967 N	FIGURE 2-2 BEDROCK GEOLOGY CROSS-SECTION LINE ATLANTIC ENVIRONMENTAL SERVICES, INC.

The Potter Hill Granitic Gneiss is an orange-pink to light gray, medium-grained gneissic biotite granite. The main constituents are equal amounts of quartz and microline, oligoclase, and from 2 to 7 percent biotite and iron oxides. In both the Potter Hill Granitic and Hope Valley Alaskite Gneisses, the biotite tends to be concentrated on the boundaries of lenses.

One occurrence of the Westerly Granite has been mapped on the northwest portion of NSB-NLON. The Westerly Granite occurs in dikes of gray fine- to medium-grained, equigranular granite that is composed of primarily calcic oligoclase with equal amounts of quartz and microcline, about 3 percent biotite, 1 percent muscovite and accessory minerals.

2.1.2 Surficial Geology

Information regarding the surficial geology present at the site was obtained from the USGS Surficial Geology of the Uncasville Quadrangle Map (Goldsmith 1960). Figure 2-3 illustrates the surficial geology of the NSB-NLON area. Soils classification data is shown on Figure 2-4, which is based on the 1983 Soil Conservation Service (SCS) Soils Map.

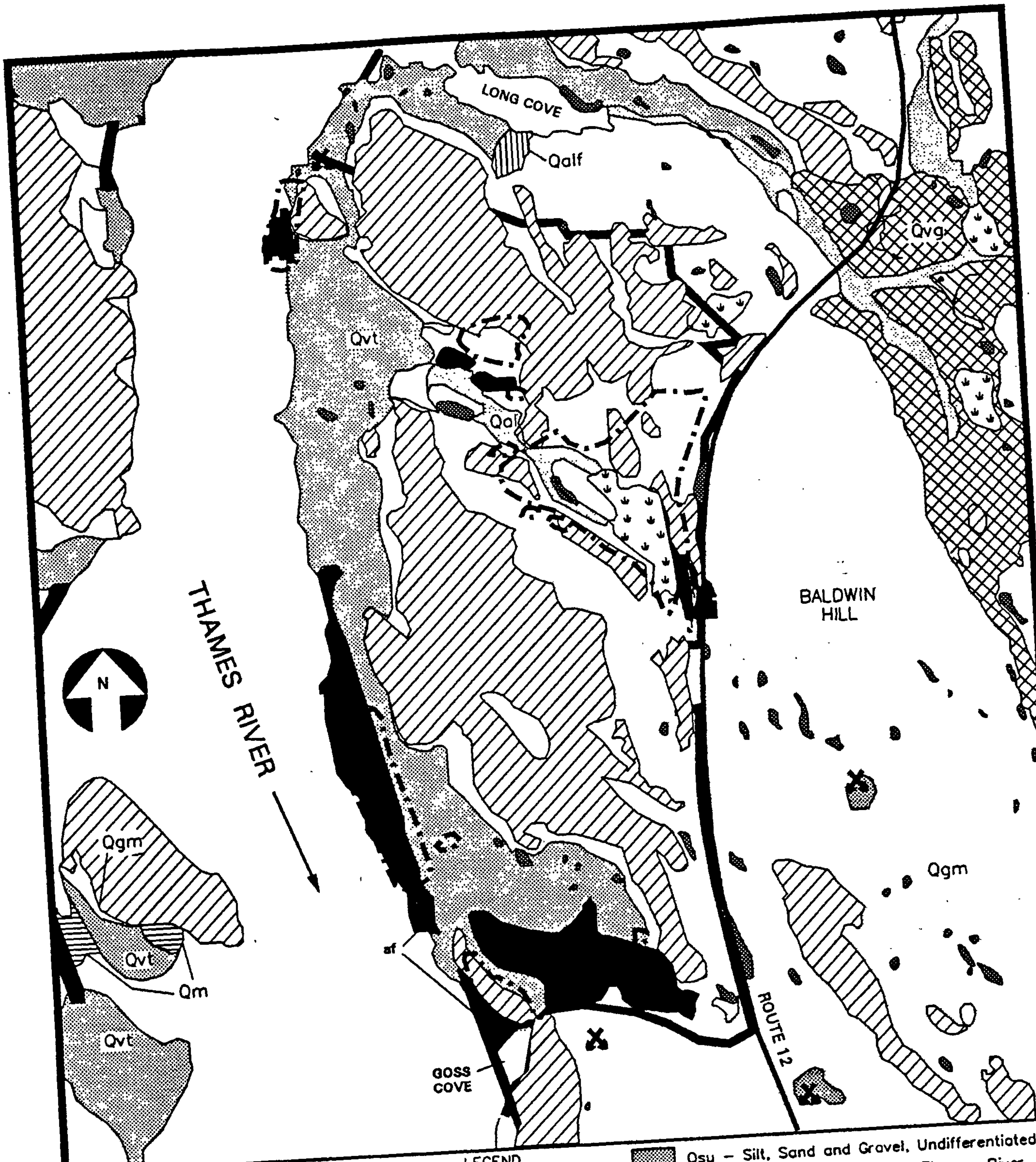
Most of the surficial deposits onsite are unconsolidated glacial materials deposited during the Pleistocene Age. The remainder of the surficial deposits are the products of post-glacial geologic processes and man-made modifications.

The glacial deposits are divided into two types: non-stratified drift (also known as till or ground moraine) and stratified drift (also known as outwash). Non-stratified drift was deposited in direct contact with the glaciers. Stratified drift was deposited by meltwater streams from a near or distant ice mass.

Most of the bedrock onsite is mantled by a thin layer of till which consists of a dense, heterogeneous mixture of clay, silt, sand and rock fragments ranging in size from cobbles to boulders. The majority of the material is unstratified but locally contains small pockets or lenses of stratified sand and gravel. Till is exposed on most of the upland surface and underlies outwash materials in the valleys. It varies considerably in thickness and in some places is absent, but averages less than 10 feet thick. The till is thickest on the north slopes of hills and thin to absent on the summit and south sides. Till on the site consists of either locally fissile, bouldery sand and gravel or a fissile, bouldery, silt and clay.

Till has been mapped at the Area A Landfill, OBDANE, CBU Drum Storage Area, and the Rubble Fill at Bunker A-86.

Stratified drift is stratified silt, sand and gravel that was deposited by glacial meltwater. As the ice melted and local base levels of streams were lowered, the stratified deposits were left as ridges, mounds, terraces and pitted valley floors. At NSB-NLON, stratified drift is shown as terrace deposits of the Thames River and is mapped in the western portion of the site, at the southwestern end of the site adjacent to the former location of Crystal Lake, and beneath such sites as the southern portion of DRMO, the Area A Downstream, and portions of the Lower Subase. The Spent Acid Storage and Disposal Area is located on the contact between stratified drift and the limit of artificial fill in the southeastern part of the site.



LEGEND

- Qm – Marsh Deposits
- Qs – Swamp Deposits
- Qal – Alluvium
- Qaif – Alluvial/ Colluvial Fan Deposits
- Qsu – Silt, Sand and Gravel, Undifferentiated
- Qvt – Terrace Deposits along Thames River
- Qvg – Valley Train Deposits along Great Brook
- Qgm – Ground Moraine Deposits

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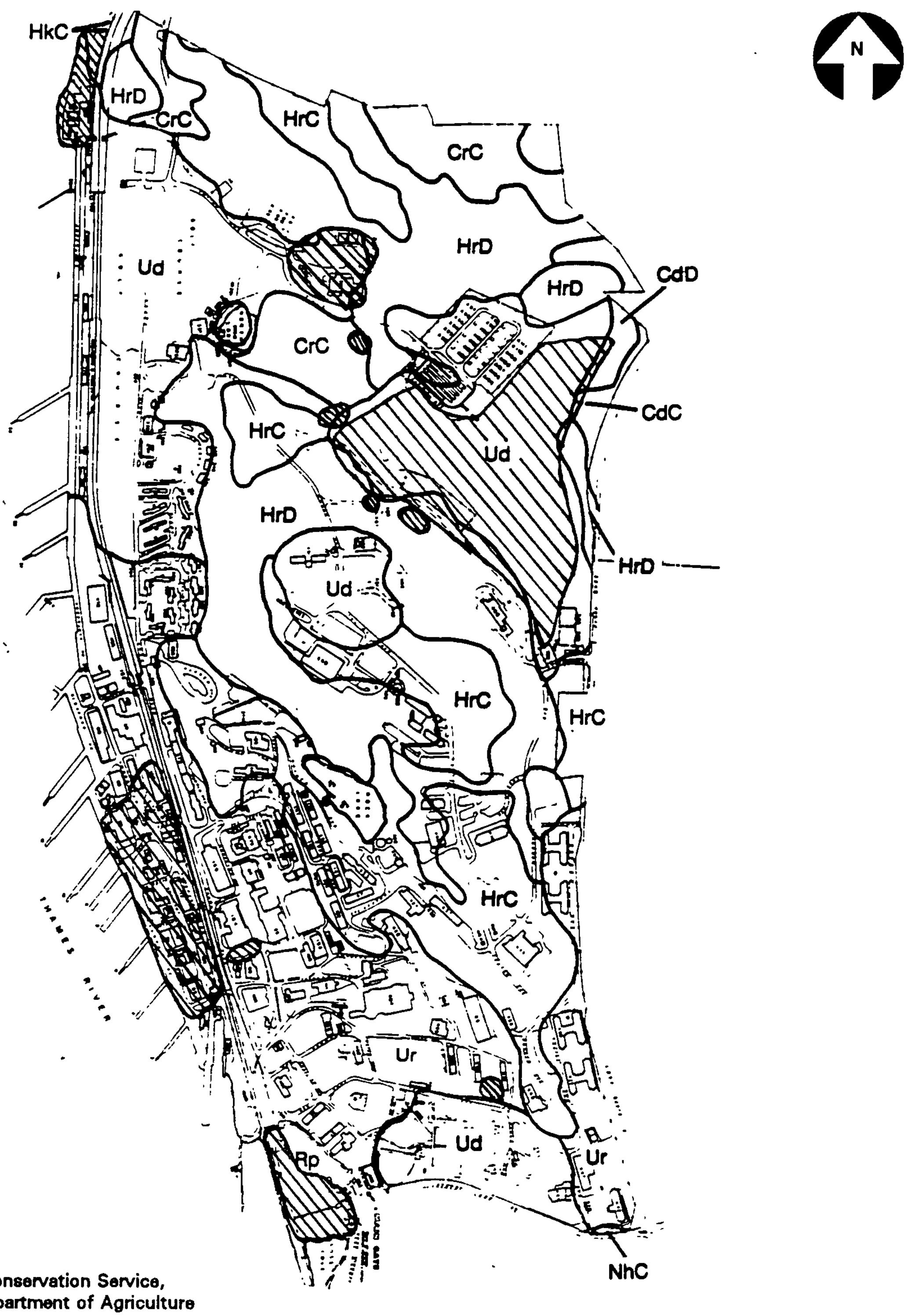
LEGEND

- – Bedrock Exposures
- – Artificial Fill
- – Borrow Pit, Active
- – Sites Investigated

SOURCE: U.S.G.S. Surficial Geology Map, 1960

FIGURE 2-3
SURFICIAL GEOLOGY MAP

ATLANTIC ENVIRONMENTAL SERVICES, INC.



SOURCE: Soil Conservation Service,
U.S. Department of Agriculture

INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND CdC - Canton and Charlton, 3-15% slopes CdD - Canton and Charlton, 15-35% slopes CrC - Charlton -Hollis, 3-15% slopes HrC - Hollis-Charlton Rock, 3-15% slopes HrD - Hollis-Charlton Rock, 15-45% slopes HkC - Hinkley Sandy Loam, 3-15% slopes NhC - Narragansett Silt Loam, 3-15% slopes Rp - Rock Outcrop-Hollis, 3-45% slopes Ud - Udorthents-Urban Land, 0-15% slopes Ur - Urban Land, surface covered by pavements or structures	FIGURE 2-4 SOILS MAP ATLANTIC ENVIRONMENTAL SERVICES, INC.

The northwestern end of the Area A Wetland, as well as OBDA and the Area A Downstream, is mapped as Quaternary Alluvium. Quaternary Alluvium consists of recently deposited sand, silt and gravel in flood plains.

Artificial fill is mapped in the areas of Goss Cove Landfill, DRMO, the majority of the Lower Subase, and the southernmost portion of NSB-NLON (former location of Crystal Lake).

Extensive bedrock outcrops are mapped and were observed throughout NSB-NLON at or adjacent to all sites except the Lower Subase.

2.1.3 Surface Water Hydrology

NSB-NLON is located on the east bank of the Thames River. The Thames River and its tributaries drain approximately 1,400 square miles of eastern Connecticut, western Rhode Island, and south central Massachusetts. The Thames River originates in Norwich Harbor, at the confluence of the Shetucket and Yantic Rivers, and discharges into Long Island Sound approximately 6 miles south of NSB-NLON. The Thames River estuary extends from Long Island Sound north 16 miles to Norwich. Widths of the river vary from 1.5 miles at New London Harbor to approximately 500 feet at Norwich Harbor.

Surface water from the site drains west toward the Thames River via streams and storm sewers. Figure 2-5 shows site drainage basins. The offsite portion of these watersheds includes a sparsely developed residential area located to the east along Route 12 and an area with limited commercial development located north of the intersection of Crystal Lake Road and Route 12.

Onsite drainage includes several streams and ponds located in the north central section of NSB-NLON. These watercourses discharge to the Thames River through discharge points located at the DRMO, on the Lower Subase north of Pier 33, and at the Goss Cove Landfill.

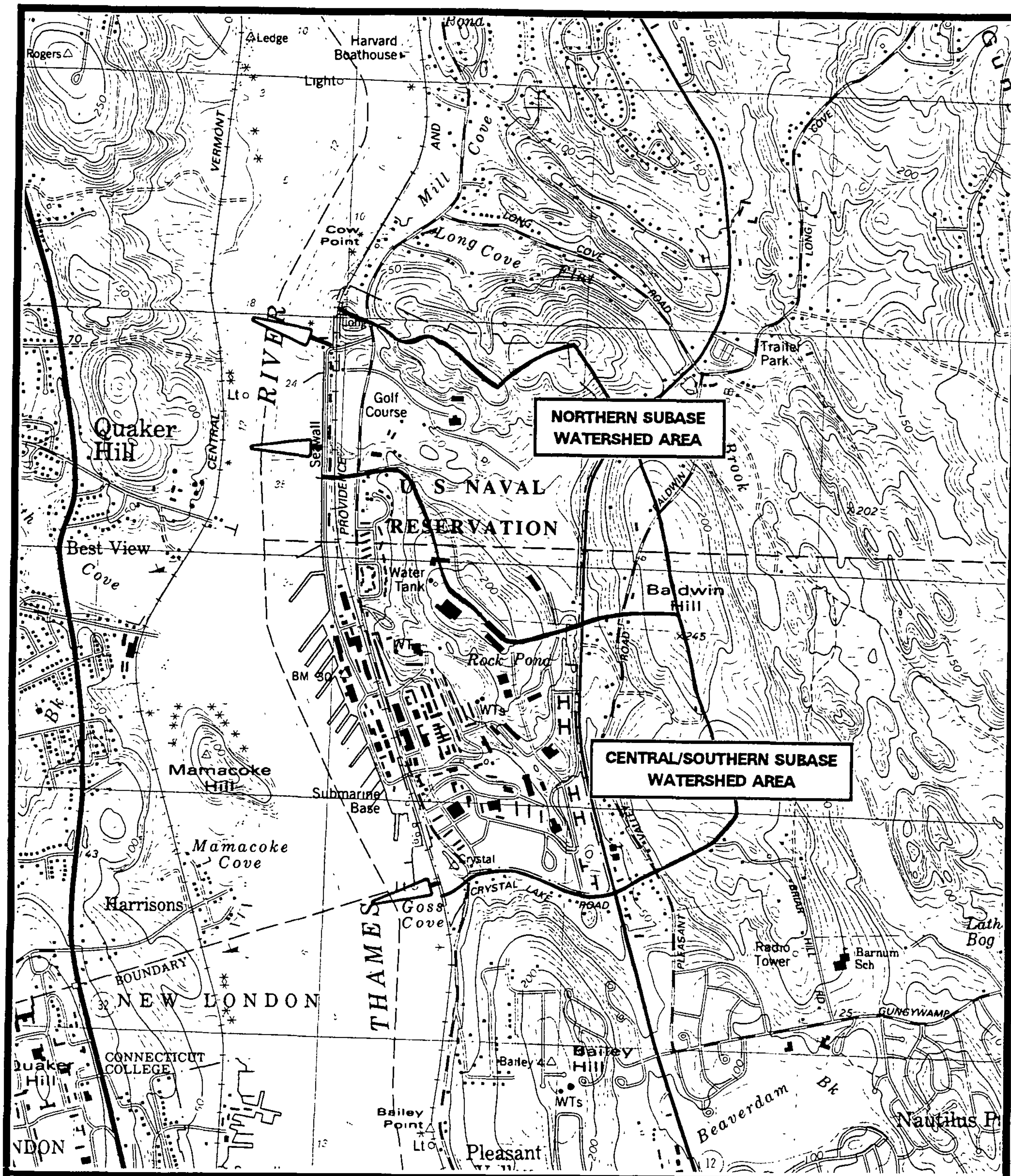
2.1.4 Ground Water Hydrology

Information on local aquifers was obtained from Connecticut Water Resource Bulletin Numbers 15 and 16 (USGS/CWRC 1968).

In the site vicinity, ground water is present in stratified drift, bedrock and to a lesser extent, till. General aquifer characteristics for each type encountered onsite are described below.

A fine-grained stratified drift aquifer is mapped on the western and southwestern portions of NSB-NLON. Mapped thickness of stratified drift ranges from 10 feet along the banks of the Thames River to a maximum depth of 80 feet at the former location of Crystal Lake in the southwestern portion of the site. Average estimated permeabilities of wells in stratified drift in the area range from 250 to 1400 gallons per day per square foot (gpd/ft^2). Well yields in the area range from 40 to 200 gallons per minute (gpm).

The bedrock in the site area consists of fractured metamorphic rock covered by glacial material that is thick in the lowlands and thinner in the uplands. In bedrock aquifers, ground



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND SOURCE: U.S.G.S. Topographic Map, 1984 Uncasville, Ct. N Major Surface Water Discharge Points	FIGURE 2-5 WATERSHED AREAS IN THE VICINITY OF NSB-NLON ATLANTIC ENVIRONMENTAL SERVICES, INC.

water movement is along joint planes rather than through intergranular openings. Well records indicate that bedrock wells in the site vicinity yield from between 1 and 65 gpm. Potential well yields in bedrock wells are dependent on degree of fracturing, topography, and type and thickness of overburden. In general, the greatest well yields occur in valleys where bedrock is highly fractured and is overlain by over 50 feet of stratified drift.

Till covers bedrock at locations previously discussed in this section. Till generally has low permeability and low water yield.

2.2 Supplemental Step I Investigation

This section summarizes existing background information and data for the two Step I sites: Construction Battalion Unit (CBU) Drum Storage Area and Over Bank Disposal Area Northeast (OBDANE). This information is summarized from information that is presented in more detail in the Phase I RI report and from any additional background information from a site inspection performed by Atlantic on February 23, 1993 and in the *Site Analysis*, U.S. EPA Environmental Monitoring Systems Laboratory, March 1992.

Regarding analytical data presented in the Phase I RI, it should be noted that boron results in ground water and soil may be inaccurate due to sulfur interference.

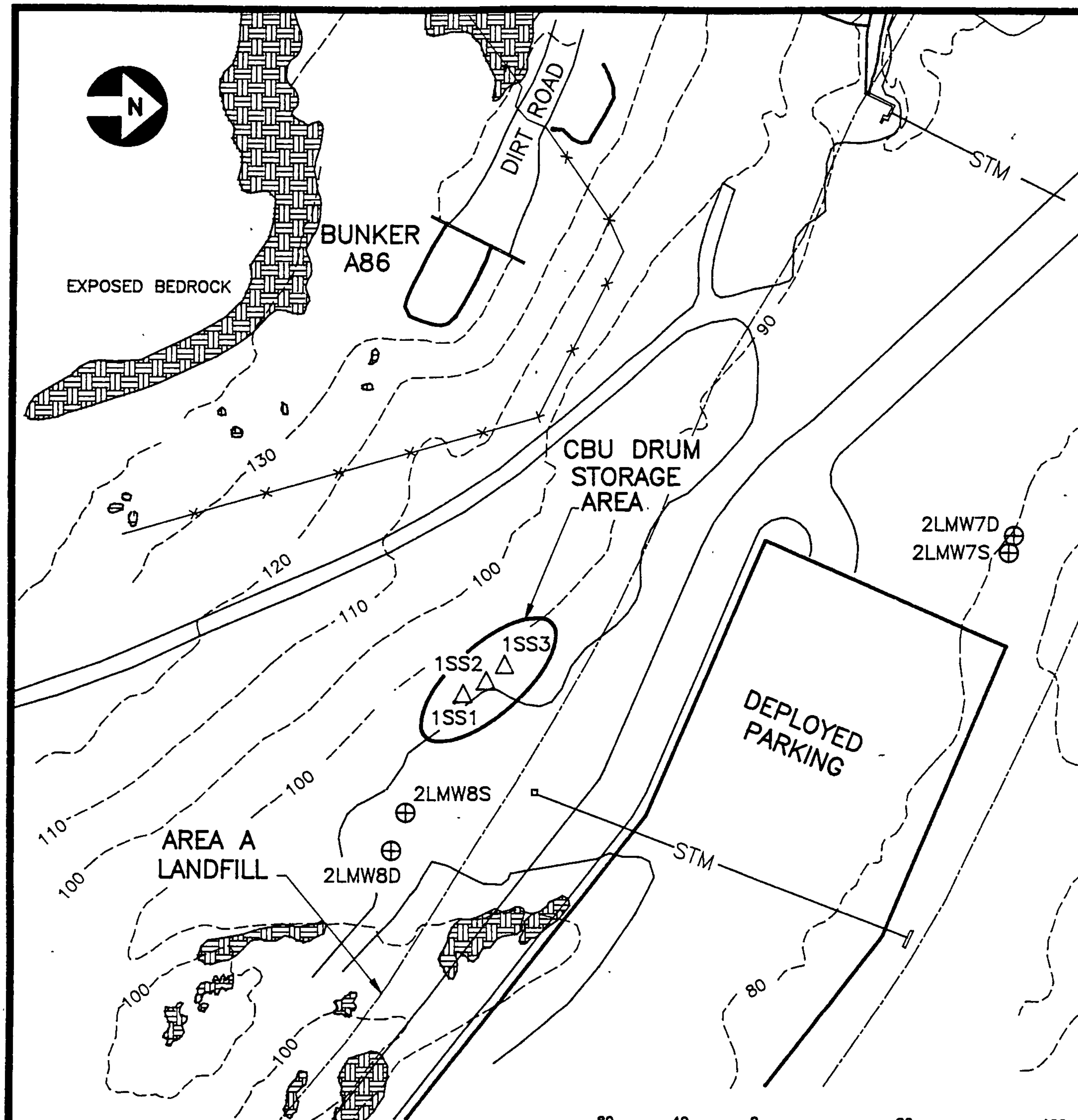
2.2.1 Construction Battalion Unit (CBU) Drum Storage Area

2.2.1.1 Site Background

The CBU Drum Storage Area is located in the northern section of NSB-NLON adjacent to the deployed personnel parking lot and on the southern limits of the Area A Landfill. Figure 2-6 indicates previous sampling locations and shows site topography, drainage features, and utility information of this site. The site is situated on a flat open area north of a wooded hillside that slopes down toward the site at a 25 to 30 percent grade. The size of the site is approximately 15 feet in width by 30 feet in length. The site is unpaved. Surface drainage from the site flows northeast across the unpaved deployed parking lot and into the Area A Wetland. Runoff does not flow to the nearby catch basin.

In 1982, the Initial Assessment Study (IAS) identified twenty-six 55-gallon drums of waste oil, lube oil, and paint materials at the site. Some of the drums were leaking at that time. The IAS concluded that the site had not been used for several years. These drums were removed shortly after the IAS inspection.

Atlantic inspected the site on October 20, 1988 and observed two 55-gallon drums labeled as engine oil. No surface soil staining or stressed vegetation was evident. According to Navy personnel, the drums noted in the IAS report were removed and properly disposed of by the Navy; the two drums observed in 1988 subsequently were removed in 1989. Atlantic re-inspected the site on February 23, 1993. There were no drums observed onsite, nor was there any visual evidence of recent storage or leakage of drums.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

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LEGEND

⊕ 6MW1	MONITORING WELL	——10——	EXIST CONTOUR
○ 6TB1	TEST BORING	123	BUILDING No.
□ 6SD1	SEDIMENT SAMPLE		WATERCOURSE
△ 6SS1	SURFACE SOIL SAMPLE	—STM—	STORM SEWER
◇ 6SW1	SURFACE WATER SAMPLE		CATCH BASIN

FIGURE 2-6
SITE PLAN
CBU DRUM STORAGE AREA

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2.2.1.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the geology of adjacent areas and interpretation of the 1967 USGS Bedrock Geology Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geology Map indicates that bedrock at this site is a biotite-quartz-feldspar gneiss of the Mamacoke Formation. No wells or borings were drilled at this site, and thus no bedrock or borings were available for study. However, depth to bedrock can be estimated based on borings located in the Area A Landfill adjacent to the site. The depths to bedrock at 2LMW8S and 2LMW17S are 20.5 feet and 18.5 feet, respectively. It is expected that bedrock at the CBU Drum Storage Area is approximately 20 feet deep. The 1983 SCS Soils Map classifies the soil as Hollis-Charlton Rock, 15 to 45 percent. This classification is consistent with the soils and topography observed at the site. The 1960 USGS Surficial Geology Map shows non-stratified drift deposits in the CBU Drum Storage Area. This classification is consistent with surface soils observed in the area. Soil samples taken from adjacent portions of the Area A Landfill indicate that this area may have been filled and that any fill is underlain by compact sand, silt, and gravel which extends down to bedrock.

No ground water monitoring was performed directly at this site. However, because of its location within Area A Landfill, ground water flow direction information can be accurately estimated. Data from Area A Landfill indicates that ground water flows northeast across the Area A Landfill and Wetland and eventually to the Thames River. The depth to ground water in adjacent monitoring well 2LMW8S has ranged from between approximately 1 to 4 feet below ground surface. Therefore, ground water at the site is also expected to be within this range.

2.2.1.3 Nature and Extent of Contamination

Seven surface soil samples were collected for analysis from three sample locations at this site to screen for potential releases from past drum storage. Use of this area for storage of drums were documented during the IAS (1982) and Atlantic (1988) inspections and the U.S. EPA aerial photograph site analysis (1992). Shallow samples were collected from the ground surface to a depth of 6 inches. Deep samples were collected from the material 12 to 18 inches below ground surface. Relatively low levels of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons, and metals were detected in some of the samples. Field-measured organic vapor readings above background levels and slight petroleum odor, were noted at 1SS1D and 1SS3D. VOCs were detected in samples 1SS2D and 1SS3D and totalled 1 and 306 ppb, respectively. Semi-volatile organics were only analyzed for in sample 1SS4C (composite of 1SS1S and 1SS2S) and totalled 820 ppb. The pesticide DDD was also detected at 1SS4C at a concentration of 55 ppb. Total petroleum hydrocarbons were detected in all of the samples analyzed ranging from 110 ppm in 1SS2S to 9,800 ppm in 1SS3D. Lead exceeded the TCLP TBC levels of 0.05 ppm at sample 1SS1S (0.6 ppm). Lead also slightly exceeded published background concentrations at 1SS4C (composite of 1SS1C and 1SS2C). The lead may have been associated with waste oil or paint materials, previously stored at the site. The U.S. EPA has requested that site-specific background levels be developed for this project. A separate approved work plan is presently being implemented to define site-specific background levels of inorganics in soils.

TBCs (to be considered values) are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. The most significant TBCs regarding this project are CTDEP's soil cleanup guidance values. TBCs will be used primarily as a screening tool to identify potential areas of concern. In addition, TBCs will be considered along with ARARs and the risk assessment in determining remedial action objectives.

2.2.2 Over Bank Disposal Area Northeast (OBDANE)

2.2.2.1 Site Background

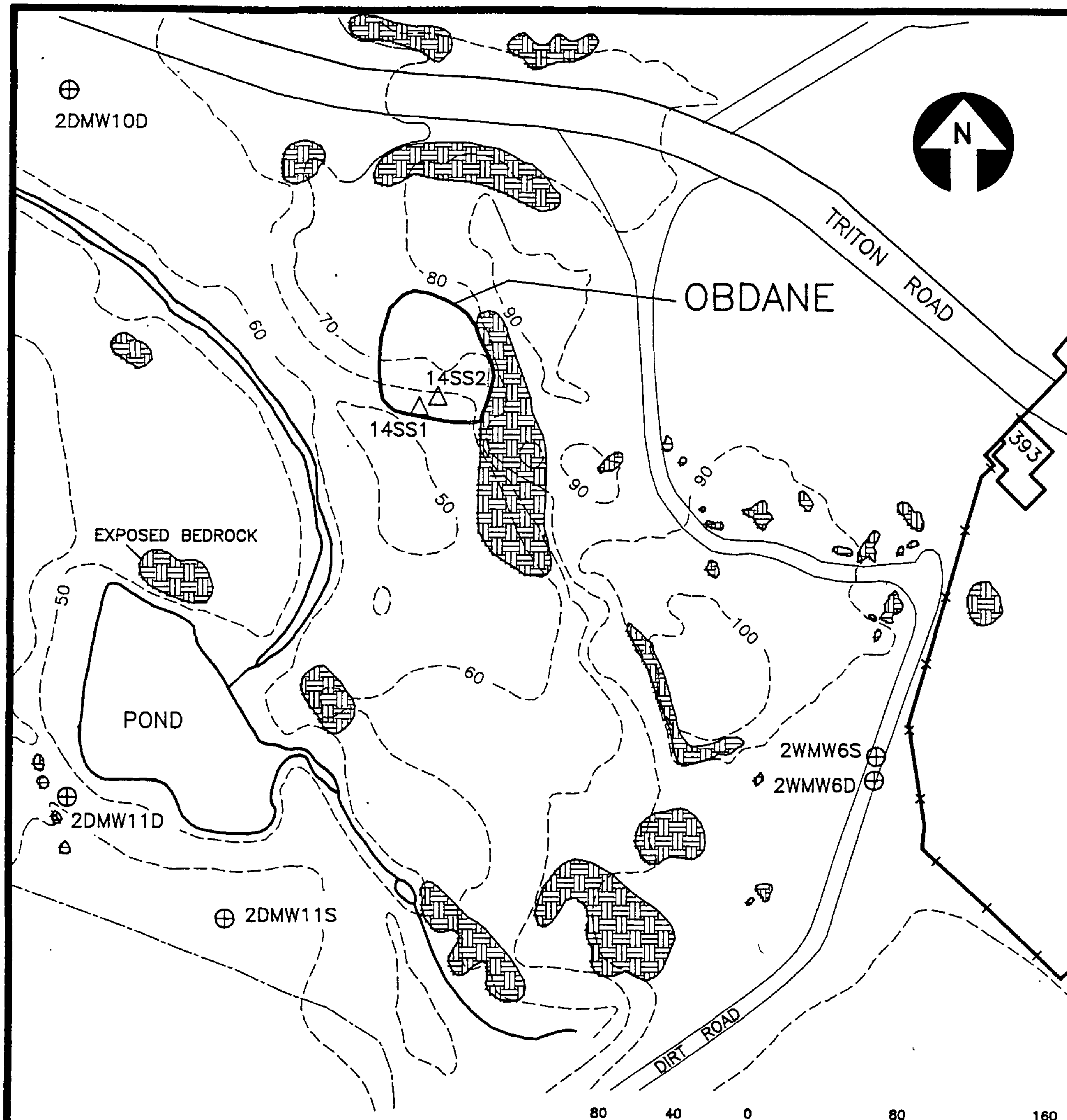
The OBDANE is located in a heavily wooded area on the edge of a ravine northwest of the Area A Landfill and south of the Torpedo Shops. At this site, a few empty containers and various debris have been discarded. A dirt road provides limited access to the site, which is wooded. Figure 2-7 indicates former sampling locations, topography and drainage features. A nearly vertical 20-foot high bedrock face is located at the eastern edge of the site. The rest of the site slopes to the southwest. Surface runoff flows to the southwest and pools at the base of the slope in a small wetland area.

The IAS report stated that the vegetation at the site indicated that no dumping had occurred within ten years of their investigation (1982). Atlantic personnel inspected the site on September 30, 1988 and February 23, 1993 and visually verified the presence of several empty drums as stated in the IAS report. There were five 55-gallon metal drums that were completely rusted and partially crushed, two 35±-gallon fiber drums that were almost completely degraded except for steel reinforcement rings, and one 1±-gallon steel box that was completely rusted.

2.2.2.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the geology of adjacent areas and interpretation of the 1967 USGS Bedrock Geology Map, the 1983 SCS Soils Map and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geology Map indicates that bedrock at this site is a biotite-quartz-feldspar gneiss of the Mamacoke Formation. No wells or borings were drilled at this site; thus no bedrock or borings were available for study. Based on observations of bedrock outcrops and depths to bedrock observed in surrounding wells 2DMW10D, 2DMW11S, and 2WMW6S, bedrock is expected to be between approximately 5 to 20 feet deep at the site. The 1983 SCS Soils Map classifies the soil as Charlton Hollis, 3 to 15 percent slopes. This classification is consistent with the soils and topography observed at the site. The 1960 USGS Surficial Geology Map shows non-stratified drift deposits in the OBDANE. This classification is consistent with surface soils observed in the area. Soil samples taken from adjacent portions of the Area A Downstream indicate that the fill material at the site is underlain by compact sand and silt, which extends down to bedrock. Based on a visual examination of surficial materials deposited at OBDANE, the fill appears to consist primarily of soil and construction rubble.



80 40 0 80 160

GRAPHIC SCALE IN FEET

NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

LEGEND

⊕ 6MW1	MONITORING WELL	——10——	EXIST CONTOUR
○ 6TB1	TEST BORING	123	BUILDING No.
□ 6SD1	SEDIMENT SAMPLE		WATERCOURSE
△ 6SS1	SURFACE SOIL SAMPLE	——STM——	STORM SEWER
◇ 6SW1	SURFACE WATER SAMPLE	□	CATCH BASIN

FIGURE 2–7
SITE PLAN
OBDANE

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No ground water monitoring was performed directly at this site. However, because of its proximity to the Area A Downstream area, ground water flow direction information can be accurately estimated. Data from Area A indicates that ground water flows west toward the Area A Downstream watercourses and eventually to the Thames River. Depth to ground water at the site is likely shallow, based on the observation of standing water near the base of the fill material at the site.

2.2.2.3 Nature and Extent of Contamination

Five surface soil samples were collected for analysis from this site, from two sample locations, to screen for potential releases from several discarded fiber drums. Sample 14SS2D contained tetrachloroethene at 2 ppb, below the TBC value of 5 ppb. Field measured organic vapor readings above background levels were recorded at 14SS1D; however, no VOCs were detected.

Samples analyzed for metals by TCLP methods did not exceed TBC values. No inorganic compounds exceeded published background levels.

2.3 Step II Investigations

This section summarizes existing background information and data for the four Step II sites (Rubble Fill at Bunker A-86, Torpedo Shops, Goss Cove Landfill, Spent Acid Storage and Disposal Area). This information is summarized from information that is presented in more detail in the Phase I RI report, and from any additional background information obtained during the preparation of this Work Plan.

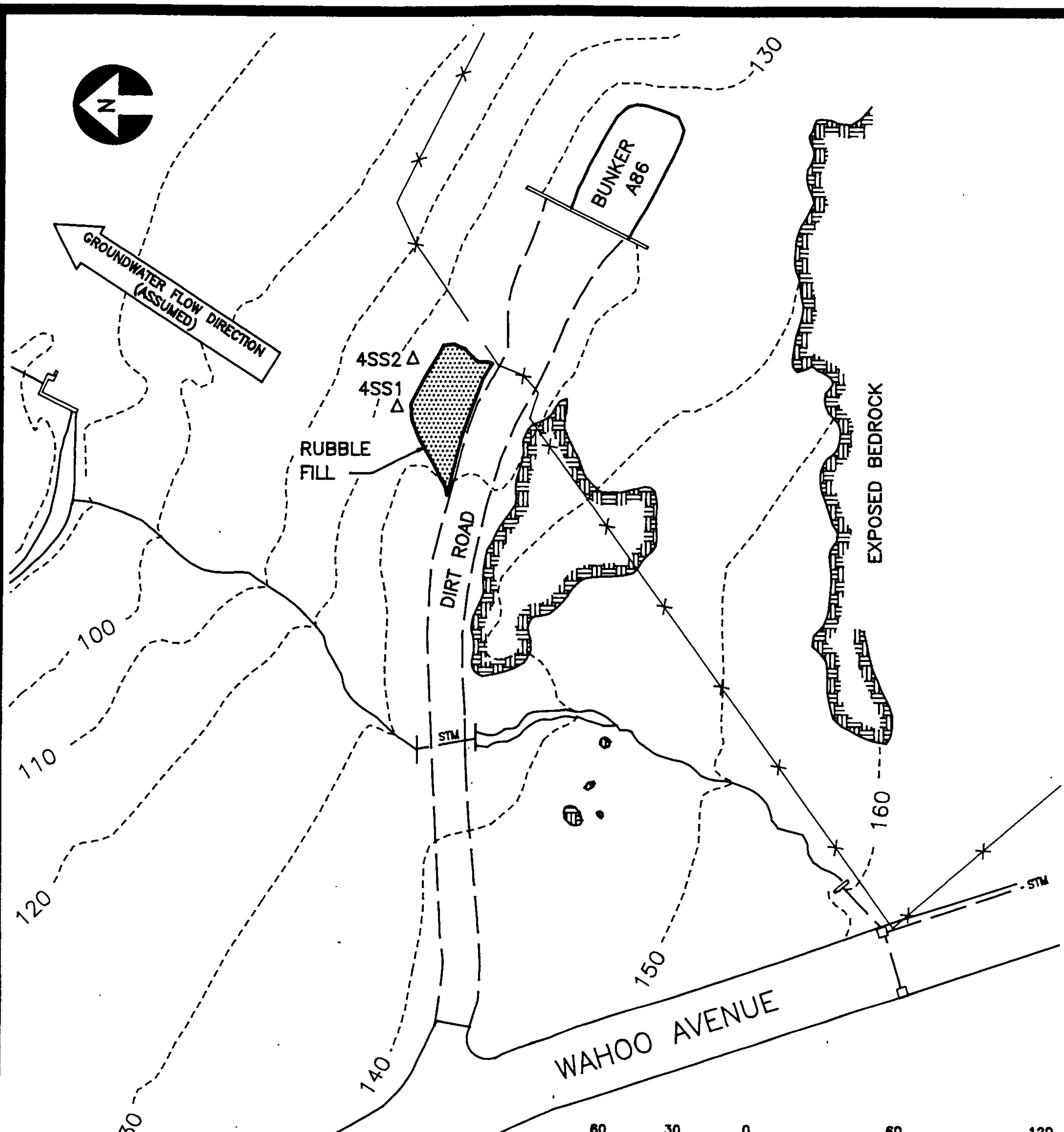
Regarding analytical data presented in the Phase I RI, it should be noted that boron results in ground water and soil have been determined to be inaccurate due to sulfur interference.

2.3.1 Rubble Fill at Bunker A-86

2.3.1.1 Site Background

Bunker A-86 is located on a dirt road off Wahoo Avenue in the north central section of NSB-NLON. The Area A Landfill is adjacent to the north, and the NSB-NLON hazardous waste storage facility is adjacent to the south. The rubble fill area is located north of the dirt access road and west of the bunker. A site plan, including previous sample locations, is provided in Figure 2-8.

Discarded construction material is present at this site including concrete, asphalt, an electric motor, wood, and gravel. Chemical containers found at this site included an empty 5-gallon container of monothanolanine (labelled as corrosive product), an empty 5-gallon container of thorite (labelled as non-shrinking compound for patching concrete), and a 55-gallon drum of lube oil that was approximately 10 percent full.



60 30 0 60 120

GRAPHIC SCALE IN FEET

NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

LEGEND

⊕ 6MW1	MONITORING WELL	---10---	EXIST CONTOUR
○ 6TB1	TEST BORING	123	BUILDING No.
□ 6SD1	SEDIMENT SAMPLE		WATERCOURSE
△ 6SS1	SURFACE SOIL SAMPLE	—STM—	STORM SEWER
◇ 6SW1	SURFACE WATER SAMPLE	□	CATCH BASIN

FIGURE 2-8
SITE PLAN
RUBBLE FILL AT BUNKER A86

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2.3.1.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the geology of adjacent areas and interpretation of the 1967 USGS Bedrock Geology Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geology Map indicates that bedrock at this site is a biotite-quartz-feldspar gneiss of the Mamacoke Formation. No wells or borings were drilled at this site, and thus no bedrock or borings were available for study. The 1983 SCS Soils Map classifies the soil as Hollis-Charlton Rock, 15-45 percent slopes. This classification is consistent with the soils and topography observed at the site. The 1960 USGS Surficial Geology Map shows non-stratified drift deposits in the rubble fill area. This classification is consistent with surface soils observed in the area. Soil samples taken from adjacent portions of the Area A Landfill indicate that the fill material at the site is underlain by compact sand, silt and gravel which extends down to bedrock.

No ground water monitoring was performed at this site. Data from adjacent areas suggests that ground water flows northwest toward the Area A Landfill and Downstream, and eventually to the Thames River.

2.3.1.3 Nature and Extent of Contamination

Five surface soil samples were collected for analysis from this site from two sample locations to screen for contamination. Solvents (trichloroethene, tetrachloroethene) were detected in the 1-2 parts per billion (ppb) range, below to be considered (TBC) values. One sample was analyzed for semi-volatile organic compounds (SVOCs) and contained elevated concentrations of polyaromatic hydrocarbons (PAHs), possibly indicative of an oil release or combustion by-products. Low concentrations of pesticides (delta-BHC, methoxychlor) possibly associated with past Area A applications were also detected. Arsenic was present at a concentration well above published background levels in the one sample analyzed on a mass weight basis. The concentration of arsenic (127 parts per millions (ppm)) was one of the highest detected at any of the sites investigated.

2.3.2 Torpedo Shops

2.3.2.1 Site Background

The Torpedo Shops are located in the northern portion of NSB-NLON on the north side of Triton Avenue. The two buildings onsite (Nos. 325 and 450) are torpedo overhaul/assembly facilities. These facilities were connected to an onsite septic system leach field until 1983, when they were connected to municipal sewers. A variety of fuels, solvents and petroleum products are used in these buildings. Otto fuel, used in torpedoes, is also stored onsite. Direct disposal of these wastes to the septic system was not reported to be a routine practice, although sporadic, inadvertent chemical discharges to the subsurface septic system could have occurred. In addition, chemicals and chemical waste associated with overhaul activities such as paints and solvents have been stored onsite.

A site plan of this site, including previous sample locations, is provided as Figure 2-9.

In November 1989, an evaluation was conducted of soil contamination in the area around the abandoned waste Otto fuel sump and tank at Building 450, and of the integrity of the floor drains leading to the Otto fuel tank (GZA 1989).

The following conclusions are excerpted from these evaluations. Pertinent sections of the evaluation and information regarding Otto fuel are included as Appendix A.

- There is evidence of soil contamination in the immediate vicinity of the waste Otto fuel sump/tank. The compounds present include mineral spirits, acetone, Freon 113, tetrachloroethene and xylenes.

- The contamination was observed in soil samples collected at depths corresponding to the bottom of the tank or lower. This may indicate that the source of the contaminants is leakage from the tank. However, it is also possible that leakage may have occurred in the pipelines beneath the building and migrated within the fill or ground water beneath the building.

- Analytical results indicate the presence of Otto fuel II in the sump and floor drainage system. Separate liquid phases were evident in the sump and "running trap" samples. The sump sample was obtained from a small puddle of liquid remaining in the tank after it was emptied by the Navy.

- Visual observations and field organic vapor screening results suggest the presence of VOCs such as solvents in most, if not all, of the floor drainage system lines. Elevated HNu readings were noted in the rooms located on the south side of Building 450, where the majority of Otto fuel handling reportedly takes place. Visual notations on the samples flushed from the lines with alcohol indicated the presence of yellowish or greenish liquid layers, with some floating oil and settleable solids (Note: Otto fuel is relatively nonvolatile and the headspace over samples of pure Otto fuel does not yield elevated (+1.0 ppm) readings).

- Blockage or major leakage of piping between the safety shower drain, located in the garage outside of the handling area, and the running trap was suggested by the flush test performed in this section. When liquid was introduced into the drain, it did not appear at the trap, although building plans show a direct connection.

- Due to the potential damage to the torpedo equipment and the building, as well as its negative impact on torpedo operations, it was concluded that the preferred approach would be to clean and abandon the system in place rather than attempt to remove the piping from beneath the structure.

- Leakage was detected at all five drain locations tested in the fuel drain system.

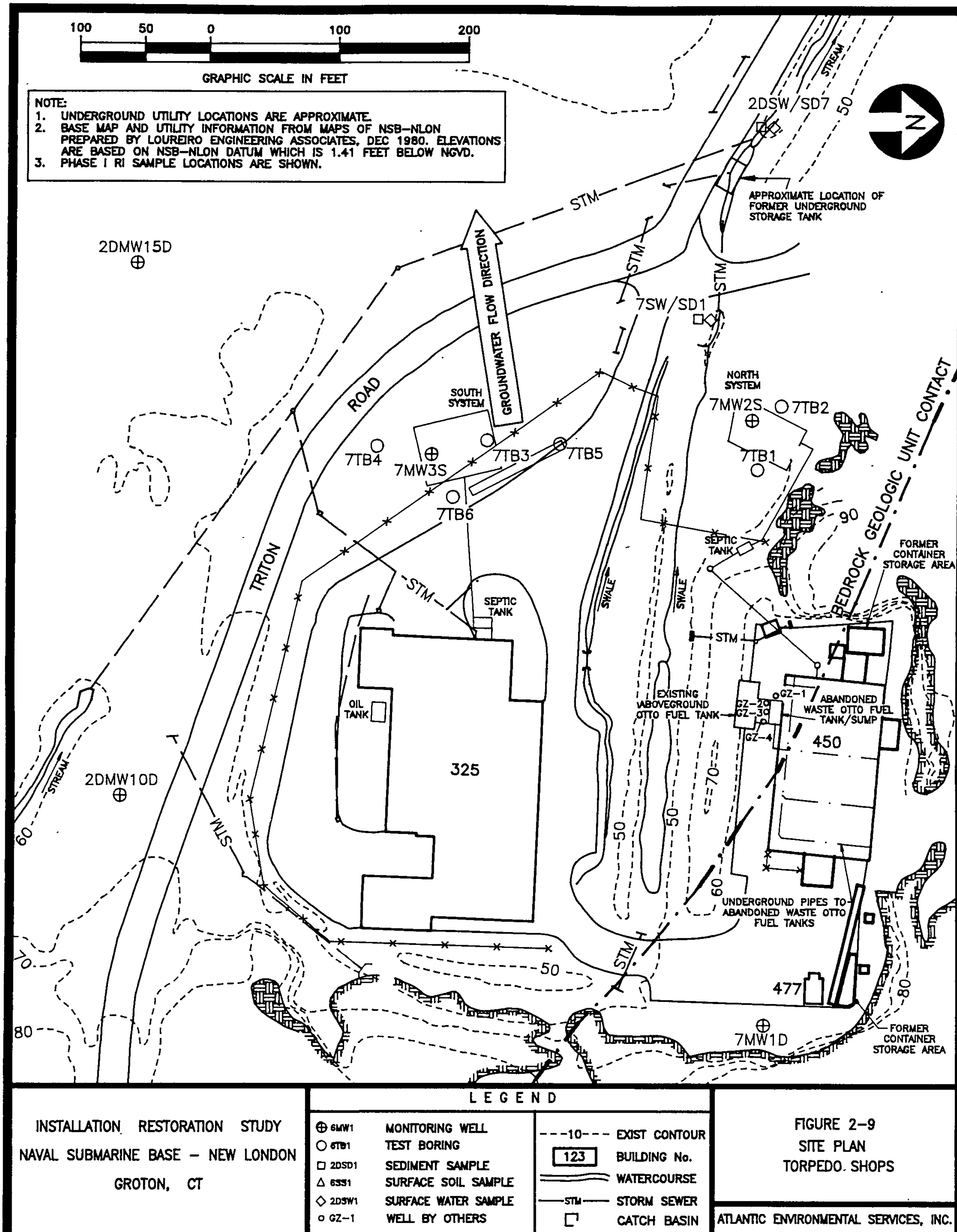

FIGURE 2-9
SITE PLAN
TORPEDO SHOPS

- For each 2 to 3 linear feet of pipe nearest the tested floor drain locations, an equivalent hole of 0.14-inch diameter exists.

- Based on calculations, the air test only tested the integrity of the first 2 to 3 linear feet of pipe from each drain location, representing about two pipe joints. This may be due to the existence of pipe traps not shown in floor drain construction plans available.

- The entire floor drain system is believed to be constructed of soldered bell and spigot joints which are not generally as leak proof as threaded, welded or flanged connections.

- Since the entire drain system is constructed in a similar manner, it is likely that the leakage found nearest the tested floor drains is prevalent throughout the system. By projection, an equivalent hole of 0.14-inch diameter exists for every two pipe joints in the entire system.

- Taking a worst case scenario by assuming the lateral drains are flooded (fuel 4 inches deep), the maximum fuel leakage rate in the system is estimated to be 4.9 gallons of fuel per hour per pipe joint. The actual quantity may vary depending upon the condition of the pipe in those areas not amenable to testing, and actual depth and duration of fuel normally in the pipes.

During construction at the Torpedo Shops gate, an underground tank was discovered on July 15, 1992. The Navy reviewed maps and plans of this area and interviewed employees to determine the use of the tank. No information regarding the tank was discovered in any maps or plans. However, based upon interviews with employees, it appears the former owners of this property may have used the tank for heating a small building when the area was an active quarry during the 1930s.

The tank was subsequently removed and the excavation backfilled with clean sand. The tank excavation appeared to be contaminated based on odor and visual observations. A sample was taken to determine the nature of contamination. The soil was tested for aromatic and halogenated volatile hydrocarbons, polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH). All parameters tested were not detected except for TPH, which was measured at 1,200 ppm, indicating petroleum contamination was present in soils. The laboratory reports and other supporting information regarding this tank is also included in Appendix A.

2.3.2.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the Phase I RI and interpretation of the 1967 USGS Bedrock Geologic Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geology Map shows that the Torpedo Shops are located at a contact between the biotite-quartz-feldspar gneiss of the Mamacoke Formation and gneissic biotite-granite of the Sterling Plutonic Group. Figure 2-9 shows the contact between the two in the northern portion of the site. This contact was not observed in the field, nor was any bedrock coring performed to determine the nature of the bedrock at specific boring locations. The 1983 SCS Soils Map indicates Udorthents-Urban Land at the Torpedo Shops. This description is consistent with the history of quarrying and filling at the site. The 1960 USGS Surficial Geology Map depicts non-stratified drift varying from sandy, gravelly till to a more compact till containing more silt and clay-sized particles.

The following subsurface geologic conditions were determined during the installation of test borings and monitoring wells. In the southwestern portion of the site, the top 6 feet of soil consists of fine-grained sand, silt and gravel which is underlain by boulders. The boulders extend down to approximately 10 feet below the surface. Below the boulders, the subsurface material consists of sand and silt with a trace of clay from 10 feet to 20 feet. The northwestern portion of the site (in the vicinity of 7MW2, 7TB1 and 7TB2) consists of fine-grained sand and silt with a trace of clay. The easternmost boring, 7TB1, contained medium- to coarse-grained sand and gravel from 6 feet to 12 feet. In the northwestern area, auger refusal occurred at depths of 12.7, 7.3 and 11.5 feet at 7TB1, 7TB2 and 7MW2, respectively. Although no coring was performed at these locations, it is likely that bedrock is at or near these depths based on observation of nearby bedrock outcrops.

Two overburden ground water monitoring wells and one bedrock monitoring well were installed at this site. Ground water elevations in overburden wells were approximately 3 feet below grade in the northwestern portion of the site and 6 feet below grade in the southwestern portion of the site. Based on the limited amount of information available from the two overburden wells, the ground water flow direction appears to be toward the south-southwest.

Slug displacement tests were performed in overburden well 7MW2 and bedrock well 7MW1 in the Torpedo Shop area. Well 7MW2 is screened 10 feet in fine-grained sand and silt in the northwestern part of the site. The hydraulic conductivity of the fine-grained sand and silt was calculated to be 10.7 feet/day from slug test data. The ground water velocity was not calculated for this site due to limited information on the ground water gradient.

Bedrock well 7MW1 is located in the eastern part of the site and has an 11-foot open interval in the bedrock. The transmissivity of the bedrock was calculated to be 7,000 square feet per day, assuming a porous aquifer thickness of 150 feet. The transmissivity of the fracture(s)/joint(s) intersected by this well is probably greater than the calculated transmissivity.

Surface water at the site can occasionally be found in the drainage swale during storm events which extends from east to west, between Buildings 450 and 325. This water flows into the Area A Downstream, which is subsequently discussed. The surface water eventually discharges into the Thames River through a culvert located at the DRMO site.

2.3.2.3 <u>Nature and Extent of Contamination</u>

Nine surface soil samples and three ground water samples were collected and analyzed to screen for potential contamination at the former subsurface septic systems. Low concentrations of VOCs and SVOCs were detected in the north and south septic systems. Only one detection of benzene (4 ppb), was slightly above the TBC value of 1 ppb. Antimony exceeded published background levels at the majority of sample locations in the south septic system, and silver was present close to or above published background levels at the same sample locations. It is possible that the elevated antimony and silver are associated with a by-product of the torpedo overhaul process which occurred in Building 325. PCBs were detected at 600 ppb (below TBC values) in a soil sample from the north septic system. DDE was detected at 210 ppb in a soil sample from the south septic system. The source of PCBs and DDE is unknown.

No primary drinking water standards were exceeded in the three ground water samples for VOCs or metals. No SVOCs, pesticides/PCBs were detected in the ground water. Several VOCs were detected in the overburden ground water in the south septic system. These included 1,1,1-trichloroethane (42 ppb), 1,1-dichloroethene (1 ppb), and 1,1-dichloroethane (30 ppb), which were present below applicable drinking water standards. Because the soil gas survey and subsurface soil sampling within the septic leaching field did not indicate the presence of significant levels of VOCs, the presence of these solvents in the ground water suggest the potential for an undefined source. It is possible that the source of these solvents is upgradient of this location, in the vicinity of the Torpedo Shops. The former hazardous waste sump, Otto fuel storage tanks, and drum storage are possible sources. Also, due to the density of solvents, higher concentrations may be present in the bedrock aquifer. Antimony exceeded the U.S. EPA health advisory standard in the ground water (south septic system) by over 20 times. This correlates with the elevated levels of antimony detected in the soils at this site. Because the antimony was present in the upgradient soil sample (7MW1) (but not necessarily a background sample), it is unclear if the antimony in the soil/ground water is related to septic system discharges.

2.3.3 Goss Cove Landfill

2.3.3.1 Site Background

The Goss Cove Landfill is located in the southwest portion of NSB-NLON, adjacent to the Thames River. The Nautilus Museum and a paved parking lot are constructed directly over the former landfill. The Nautilus Museum is a submarine museum operated by the Navy and open to the public.

The landfill reportedly operated from 1946 to 1957 and filled in the northern portion of Goss Cove. The southern portion of Goss Cove remains as a surface water body. Incinerator ash, inert rubble, and possibly other unknown materials were disposed at the site.

A site plan of the Goss Cove Landfill, including previous sample locations, is provided as Figure 2-10.

2.3.3.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the Phase I Remedial Investigation

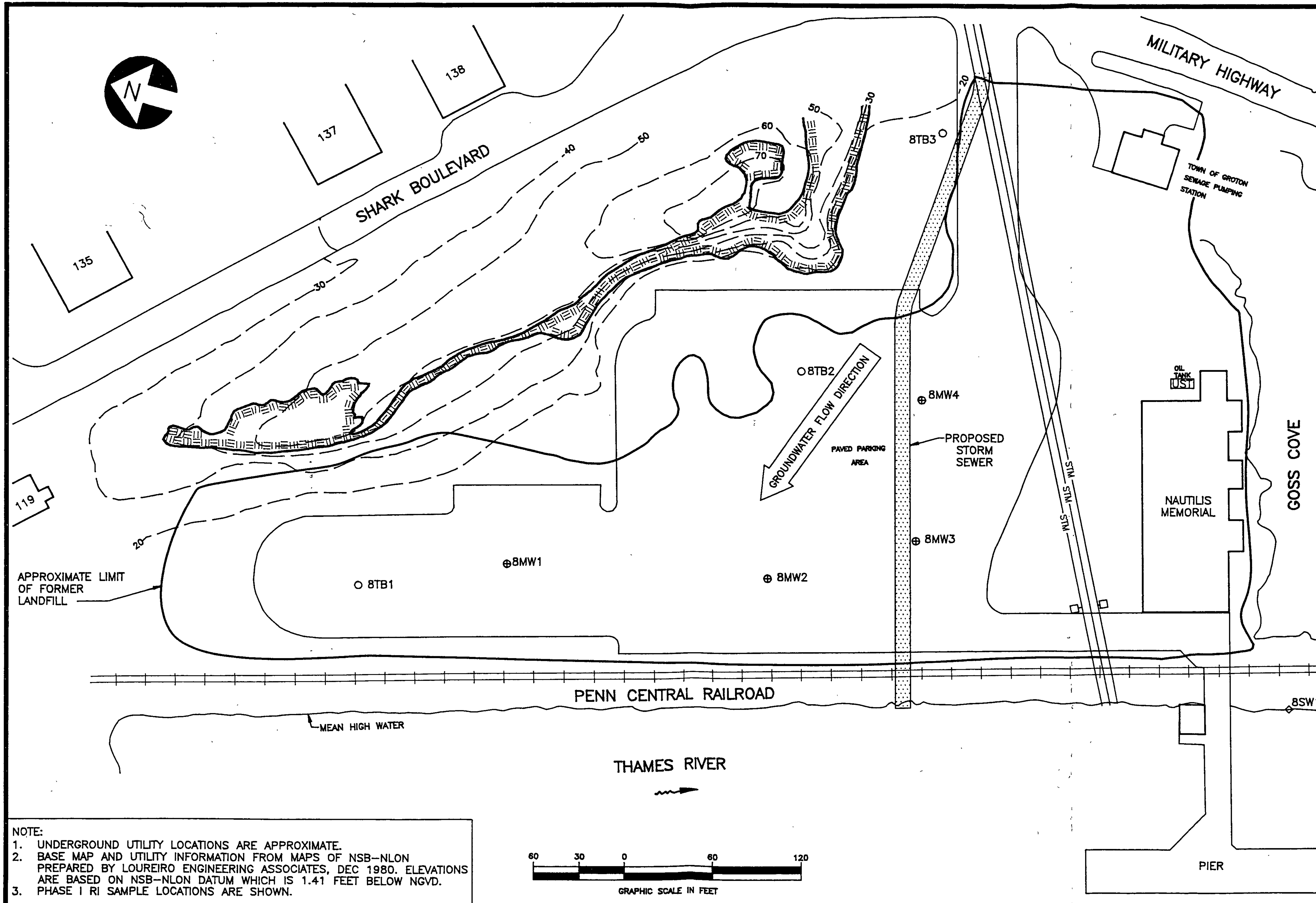

FIGURE 2–10
SITE PLAN
GOSS COVE LANDFILL

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NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

and interpretation of the 1967 USGS Bedrock Geology Map, the 1960 USGS Surficial Geology Map, and the 1983 SCS Soils Map.

The 1967 USGS Bedrock Geology Map shows the Goss Cove Landfill site as an open cove flanked on the west by the artificial fill of the railroad bed. The southwestern portion of the site is mapped as underlain by a gneissic biotite granite known as the Potter Hill Granitic Gneiss of the Sterling Plutonic Group. The bedrock in the northeastern corner of the site, which includes the outcrops present onsite, consists of a biotite-quartz-feldspar gneiss that is a member of the Mamacoke Formation. The 1983 SCS Soils Map shows the Goss Cove Landfill as rock outcrop covered by Hollis soil and urban land. The 1960 USGS Surficial Geology Map shows artificial fill at the site. This information is consistent with observed conditions.

Subsurface conditions determined during the test borings and monitoring well installation are described as follows. The western portion of the site is underlain by 10 to 20 feet of miscellaneous fill material. Fill material is generally comprised of fine- to coarse-grained sand and gravel with ash, metal fragments, glass, brick and other refuse. Below the fill material is a layer of native material consisting of fine-grained sand and silt with traces of clay, shell fragments, and organic matter. The thickness of this layer was not determined from borings drilled for this investigation. However, previous borings drilled for the construction of the Nautilus Museum indicated that this layer is between 10 and 15 feet thick and is underlain by a layer of fine sand that extends to bedrock. Refusal was encountered in two borings (8TB2 and 8TB3) located on the east portion of the site at the foot of a bedrock cliff at approximately 12 feet below the surface. Because the borings are located at the base of a bedrock outcrop, bedrock is assumed to be at this elevation. In addition to this information, depth to bedrock was also available from borings drilled for the construction of the Nautilus Museum. These previous borings indicate that the depth to bedrock is between 25 to 100 feet below grade at the site and increases from east to west.

Four overburden monitoring wells were installed at the Goss Cove Landfill. Ground water elevation is between 6 and 8 feet below the surface. Ground water elevation measurements from these wells, collected at low tide, indicate that ground water flow direction is north-northwest. A survey of the effect of the tidal cycle on ground water elevations was performed for this investigation at the Lower Subase. Data from this survey indicated that tidal fluctuation affects the ground water flow and direction at this site.

The hydraulic conductivity of the fill material was estimated to be 280 feet per day based on published values for clean sand and gravel from Freeze and Cherry (1979). The saturated thickness was estimated to be 50 feet and the perpendicular cross-sectional area was estimated to be 50 feet by 230 feet for a total of 11,500 square feet. The ground water flow velocity through the fill material was estimated to be 1.4 feet/day, and the volume of water discharging to the Thames River is estimated to be 20,400 cubic feet/day (152,600 gpd). The majority of this discharge probably is derived from the fill material which is assumed to be more permeable than the underlying fine-grained sand and silt.

Surface water from the Goss Cove site flows primarily to the Thames River which lies to the west of the site via overland flow and through a storm sewer system. Goss Cove, which lies to the south of the site, also receives some overland flow from the site.

2.3.3.3 Nature and Extent of Contamination

Radiation, geophysical, and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining elevated VOCs in several areas.

Seven subsurface soil samples, four ground water samples and one surface water sample were collected and analyzed to screen for potential contamination. Motor oil stains or sheens were observed in approximately 1/2 of the borings, indicating that petroleum disposal/spills occurred.

VOCs were detected in five of seven soil samples. Xylene was the most prevalent constituent, detected in four samples, and indicative of a petroleum product. Trichloroethene and tetrachloroethene were detected in one soil sample each. Petroleum hydrocarbons (benzene, toluene) and tetrachloroethene were detected above TBC values in one soil sample each.

SVOCs, predominantly PAHs, were detected in all seven subsurface soil samples, several at relatively high levels. The PAHs are likely associated with the disposal of incinerator ash and potentially associated with the presence of petroleum hydrocarbons.

PCBs or pesticides (predominantly DDT, DDD, and DDE) were present individually at all sample locations. All concentrations were below TBC values except for DDT at one sample location. The presence of PCBs and pesticides are probably associated with past landfill disposal.

Many inorganic constituents exceeded published background levels, and also exceeded TBC values based on TCLP analysis. Arsenic, cadmium, chromium, and lead exceeded both published background levels and TCLP TBC values. Mercury consistently exceeded published background levels at most sample locations. Elevated levels of metals are probably related to past landfilling activities and, possibly, battery-related disposal (lead/cadmium).

The highest levels of VOCs in ground water were detected in the two downgradient wells. Vinyl chloride or benzene were present individually in the ground water at a downgradient well above applicable or relevant and appropriate requirements (ARAR) values. Petroleum hydrocarbons detected (which were detected in subsurface soils) included benzene, toluene, ethylbenzene, and xylene. Trichloroethene and tetrachloroethene were not present in the ground water. Low levels of SVOCs were present in ground water, primarily the more soluble PAHs, including naphthalene. Naphthalene exceeded TBC values (U.S. EPA Health Advisory) in a downgradient monitoring well.

Barium exceeded the primary MCL at one well; secondary MCLs were exceeded for sodium, iron, and manganese in all wells. The sodium is related to the brackish water conditions.

Gross alpha and/or gross beta radiation screening values were exceeded in two monitoring wells within the landfill. These elevated readings could be the result of naturally occurring radioisotopes, but further analysis is required for confirmation.

The one surface water sample collected in the Thames River adjacent to the site did not contain VOCs, SVOCs, pesticides or PCBs. Inorganic constituent values appear consistent with brackish water. Copper was present above water quality standards.

In summary, the levels of VOCs and SVOCs in the subsurface soils impact on ground water quality (some slightly above ARAR/TBC values), but overall the concentrations are low. The elevated inorganics in soils (principally arsenic, cadmium, chromium, lead, and mercury) are not adversely impacting ground water quality.

2.3.4 Spent Acid Storage and Disposal Area

2.3.4.1 Site Background

The site is located in the southeastern section of NSB-NLON in the southern portion of the area between Buildings 409 and 410. A 4' x 4' x 12' rubber-coated underground tank was used for temporary storage of waste battery acid circa World War II. The tank top is still visible, but the tank has been filled with earth and capped with concrete.

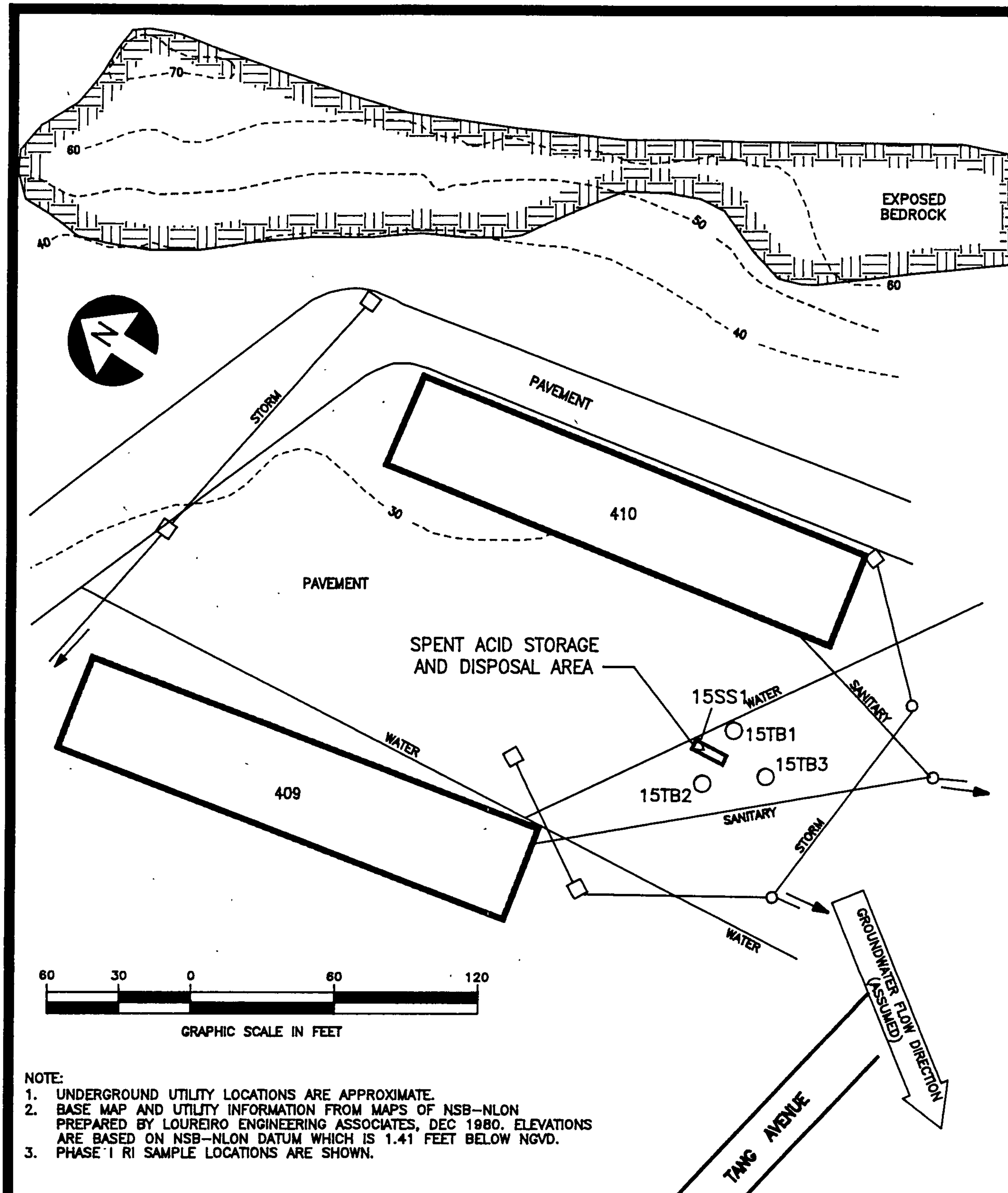
A plan for this site, including previous sample locations, is provided as Figure 2-11.

2.3.4.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the Phase I Remedial Investigation and interpretation of the 1967 USGS Bedrock Geologic Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geology Map indicates that the site is underlain by a biotite-quartz-feldspar gneiss of the Mamacoke formation. Bedrock was not encountered during the subsurface investigation. The 1983 SCS Soils Map depicts the site area as urban land. This classification is consistent with observed conditions at the site. The 1960 USGS Surficial Geology map shows that this site is located in terrace deposits of the Thames River, which consist of stratified silt, sand and gravel deposited by gravel meltwater. Subsurface material observed at the site consists of fine- to medium-grained sands and silts with traces of clay. Where clay is present, it usually occurs in discrete, silty lenses of less than 1/2 inch in thickness. Rust colored staining and mottling were common in borings located on the east and south side of the spent acid tank.

No ground water monitoring was performed at this site. Ground water was encountered at 6 to 8 feet below the surface during the drilling of test borings. Ground water flow is projected to be generally to the southwest.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

LEGEND

⊕ 15MW1	MONITORING WELL	---10---	EXIST CONTOUR
○ 15TB1	TEST BORING	123	BUILDING No.
□ 15SD1	SEDIMENT SAMPLE		WATERCOURSE
△ 15SS1	SURFACE SOIL SAMPLE	○	MANHOLE
◇ 15SW1	SURFACE WATER SAMPLE	□	CATCH BASIN

FIGURE 2–11
SITE PLAN
SPENT ACID STORAGE
AND DISPOSAL AREA

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2.3.4.3 Nature and Extent of Contamination

Seven subsurface soil samples were collected to screen for potential release of battery acid from the subsurface tank. High levels of lead were present in six of seven soil samples based on TCLP analysis. Four samples were classified as RCRA hazardous waste due to the lead concentrations. These samples were collected at the 0- to 4-foot depth interval. Several soil samples also had low pH values. The elevated levels of lead and low pH values indicate that a release of battery acid occurred. The present level of subsurface investigation has not defined the extent or degree of contamination.

2.4 Supplemental Step II Investigation

This section summarizes existing background information and data for the three Step II sites where supplemental information is required to complete the Step II (RI/FS) process. These sites are Area A, DRMO, and the Lower Subase.

2.4.1 Area A

Area A consists of four sites including the Landfill, Wetland, Downstream/OBDA, and Weapons Center. Combined, these sites comprise the study area.

2.4.1.1 Site Background

The **Area A Landfill** is located in the northeastern and north-central section of NSB-NLON. It is approximately seven acres in size. Access is via a dirt road off Wahoo Avenue. The Area A Landfill is a relatively flat area bordered by a steep, wooded hillside that rises to the south, a steep wooded ravine to the west, and the Area A Wetland to the north. Aerial photographs show that the landfill appears to have extended east along the wetland as far as the present position of the tennis courts. Runoff from the landfill drains as overland flow north into the Area A Wetland, which subsequently discharges to the Area A Downstream and into the Thames River.

A site plan of the Area A Landfill and Wetland, including previous sample locations, is provided as Figure 2-12.

The landfill opened some time before 1957. The base incinerator ceased operating in 1963, and from 1963 to 1973 all wastes were disposed in the landfill unburned. During this time, all non-salvageable materials generated by the submarines and base operations were disposed of in the Area A Landfill.

Landfill operations ceased in 1973. After closure, a concrete pad was constructed in the southwest portion of the landfill for aboveground storage of industrial wastes. The remainder of the landfill is not paved. At the time of the IAS survey, 42 steel drums, 87 transformers (mineral and PCB), and 60 to 80 electric switches were stored on the pad. Two transformers and several electrical switches were leaking at that time. Past leakage of oil was also evident. Most drums were stacked on wooden pallets and those with PCB labels were covered and bound

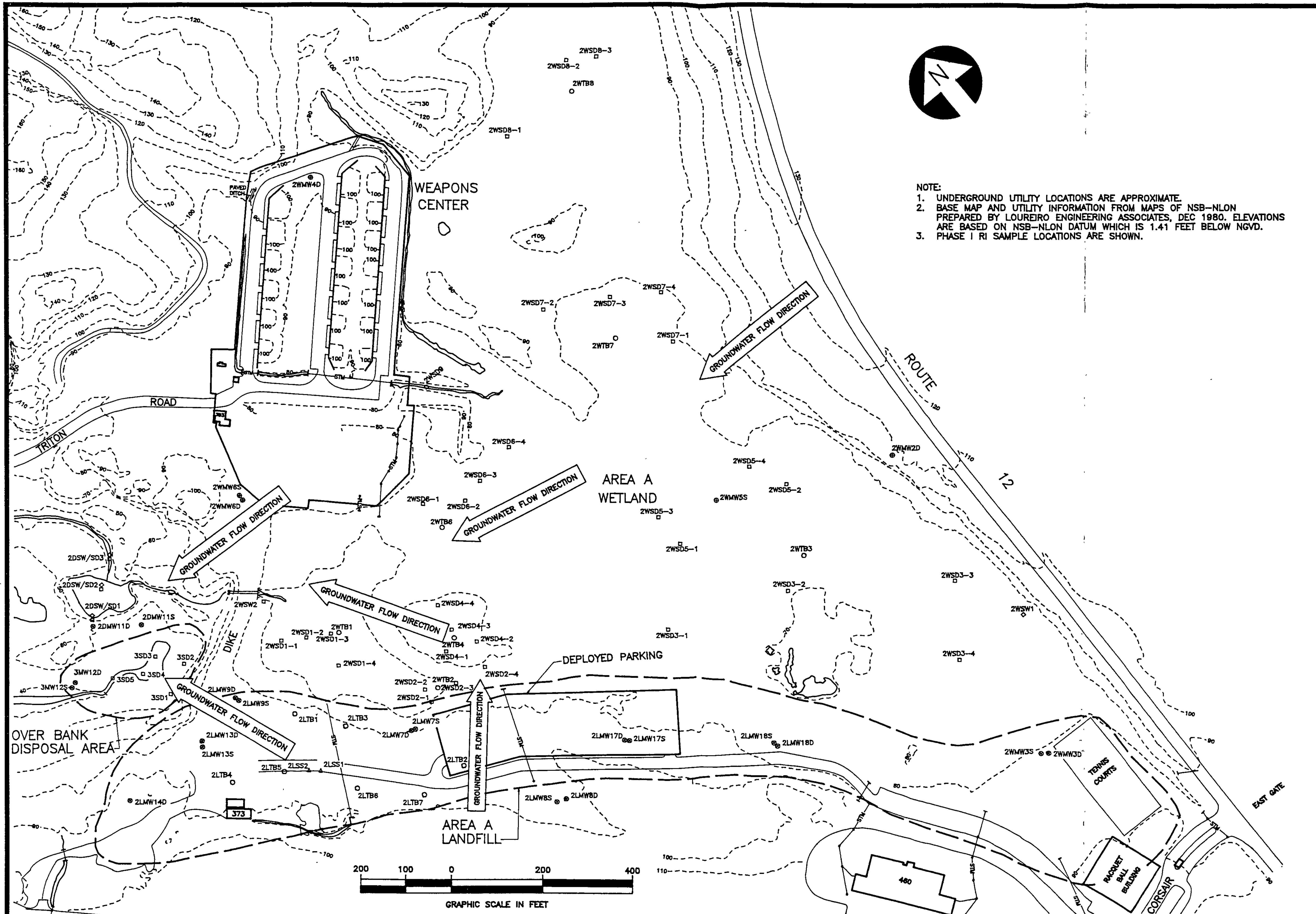


FIGURE 2-12
SITE PLAN
AREA A LANDFILL, WETLAND AND WEAPONS CENTER

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

⊕ 6MW1	MONITORING WELL
○ 6TB1	TEST BORING
□ 2DSD1	SEDIMENT SAMPLE
△ 6SS1	SURFACE SOIL SAMPLE
◇ 2DSW1	SURFACE WATER SAMPLE
---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—	STORM SEWER
□	CATCH BASIN

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

with plastic sheeting. All of these materials have since been properly disposed of offsite.

Sand bags and contractor's supplies and equipment have, in recent years, been stored over the former landfill. Several transformers, excavated underground storage tanks, crane weights, and other equipment are stored on the concrete pad in the southwest portion of the landfill. The specific items stored in this area changed over time. A gravel covered, long-term vehicle parking lot (developed parking), also exists on the former landfill.

The construction of a paved parking lot on the southeast end of the Area A Landfill was planned, but has been delayed indefinitely.

The **Area A Wetland** abuts the north side of the landfill and is approximately 30 acres in size. The maximum sediment thickness is approximately 35 feet, based on boring information. Until 1957, this portion of the site was undeveloped, wooded land. In 1957, dredge spoils from the Thames River were pumped to this area and contained within an earthen dike that extends from the Area A Landfill to the south side of the Weapons Storage Area. Atlantic learned during the course of this study that pesticide "bricks" were previously placed on the wetland ice during winter and allowed to discharge into the wetland for mosquito control.

A site plan of the Area A Wetland is included in the previously referenced Figure 2-12.

The watercourses within **Area A Downstream** drain from the Area A Landfill and Wetland. The Area A Downstream watercourses include North Lake and several small streams that discharge from Area A and the Torpedo Shops and ultimately discharge to the Thames River.

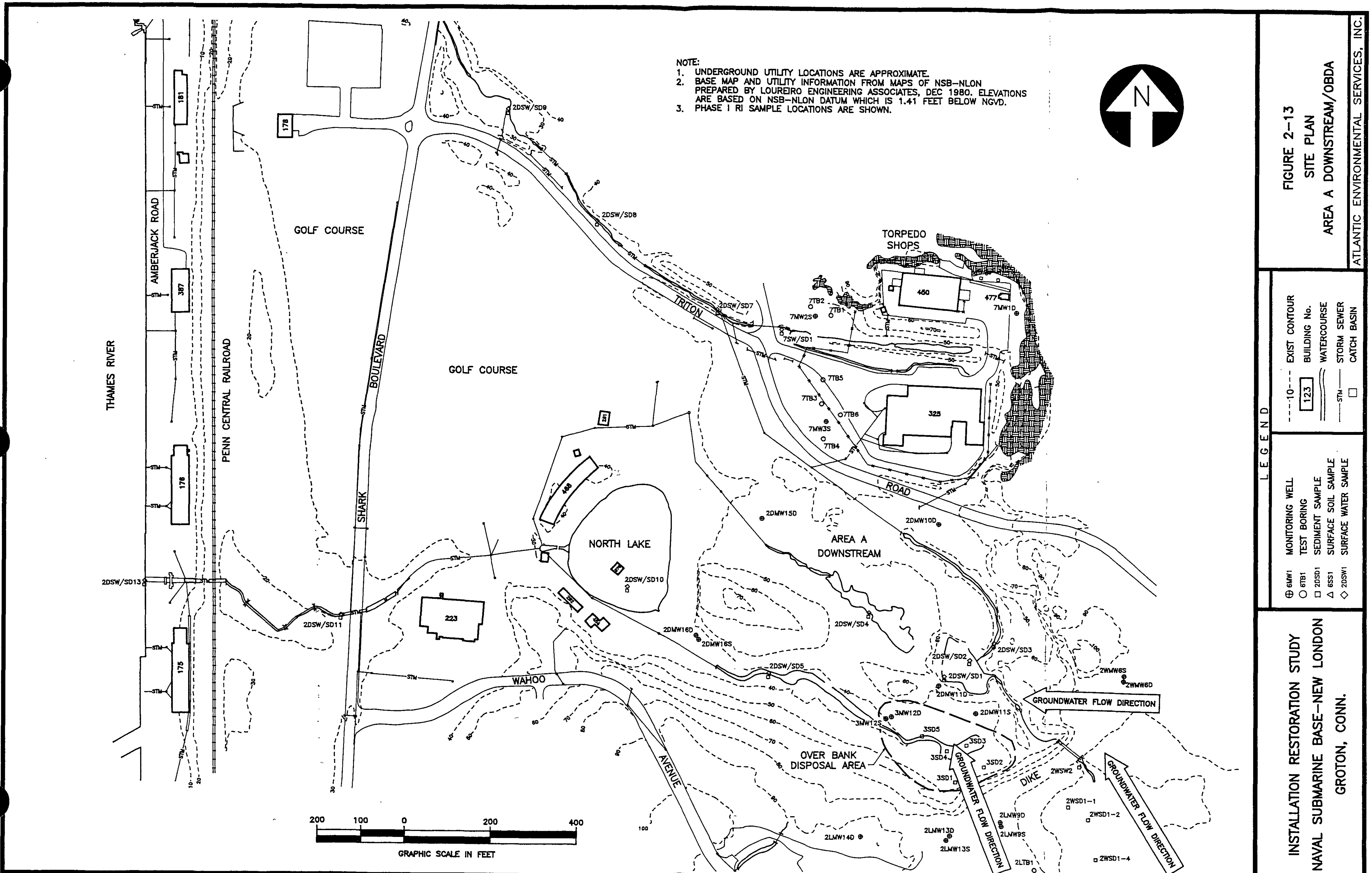
A site plan of Area A Downstream, which includes previous sample locations, is provided as Figure 2-13.

Ground water also discharges from the Area A Wetland to a small wetland at the base of the dike and the OBDA site. A stream flows from this wetland west toward North Lake, a recreational swimming area for Navy officers. The stream enters a culvert which bypasses the pond and discharges to a stream below the outfall of the pond. This stream flows west under Shark Boulevard and through the golf course to the Thames River. There is a manhole adjacent to North Lake, which was previously connected to a pipe designed to discharge overflow water from North Lake. This pipe has been plugged to prevent any possible discharge from the stream to North Lake.

Further development is not planned for this area.

OBDA is located on the slope of the dike below and adjacent to the Area A Landfill. A small wetland exists at the base of the dike.

A plan for this site was included in the previously referenced Figure 2-13.


NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
N
THAMES RIVER
AMBERJACK ROAD
PENN CENTRAL RAILROAD
GOLF COURSE
GOLF COURSE
SHARK BOULEVARD
TRITON ROAD
TORPEDO SHOPS
NORTH LAKE
AREA A DOWNSTREAM
WAHOO AVENUE
OVER BANK DISPOSAL AREA
DIKE
GROUNDWATER FLOW DIRECTION
GROUNDWATER FLOW DIRECTION
GROUNDWATER FLOW DIRECTION
2DSW/SD9
2DSW/SD8
2DSW/SD7
7SW/SD1
2DSW/SD13
2DSW/SD11
2DSW/SD10
2DSW/SD4
2DSW/SD5
2DSW/SD3
2DSW/SD2
2DSW/SD1
2DMW15D
2DMW10D
2DMW16D
2DMW16S
2DMW11D
2DMW11S
3MW12D
3MW12S
3SD1
3SD2
3SD3
3SD4
3SD5
2WMW6S
2WMW6D
2WSW2
2WSD1-1
2WSD1-2
2WSD1-4
2LMW9D
2LMW9S
2LMW13D
2LMW13S
2LMW14D
2LTB1
7TB1
7TB2
7TB3
7TB4
7TB5
7TB6
7MW1D
7MW2S
7MW3S
181
387
178
175
178
223
450
477
325
231
468
200 100 0 200 400
GRAPHIC SCALE IN FEET
LEGEND
6MW1 MONITORING WELL
6TB1 TEST BORING
2DSD1 SEDIMENT SAMPLE
6SS1 SURFACE SOIL SAMPLE
2DSW1 SURFACE WATER SAMPLE
10 EXIST CONTOUR
123 BUILDING No.
WATERCOURSE
STM STORM SEWER
CATCH BASIN
FIGURE 2-13
SITE PLAN
AREA A DOWNSTREAM/OBDA
ATLANTIC ENVIRONMENTAL SERVICES, INC.
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

This area became a disposal site after the earthen dike was constructed in 1957. It was the finding of the previous studies (1982) that the material had been there for many years and included 30 partially covered 200-gallon metal fuel tanks and scrap lumber.

Atlantic personnel inspected the site in September 1988 and observed approximately 30 empty, unlabeled 200-gallon tanks, old creosoted telephone poles, several empty unlabeled 55-gallon drums, and rolls of wire. Bright orange, organic sediments apparently leachate from the landfill were observed in the water discharging from the base of the dike embankment (apparently leachate from the landfill).

The **Weapons Center** site consists of Building 524 and the weapons storage bunkers. The storage bunker area is divided into two portions (north and south areas), each constructed at different times and of different design. The site is located at the end of Triton Avenue to the north and adjacent to the Area A Wetland. A site plan is shown in Figure 2-12 and Plate 1. Building 524 is only shown in Plate 1.

The Weapons Center (Building 524) is located near the top of a bedrock ridge. The building was constructed in 1990-1991. Portions of the site were blasted to remove bedrock to allow construction of the building. The bunkers are located south and downhill of Building 524 adjacent to and at a slightly higher elevation than the wetlands. Surface run-off from the bunker storage area flows to the wetlands via overland flow in small grassed swales and drainage culverts.

Prior to construction of the Weapons Center, the site consisted of woodlands in the area of Building 524 and wetlands in the bunker areas. Based upon a review of aerial photographs, the southern group of storage bunkers are first evident in a June 1, 1969 aerial photograph and the northern group of storage bunkers are first evident in a photograph dated February 24, 1974. Building 524 is first evident in a photograph dated May 30, 1991.

Atlantic inspected the Weapons Center, accompanied by Lieutenant Commander Fyvie, on September 11, 1992. The following information was obtained during the site inspection. Building 524 is used for administration, minor torpedo assembly, and storage of simulator torpedoes. No weapons production takes place in this building. Small quantities of chemicals and chemical waste generated by activities in this building are stored in 1 to 5 gallon containers in seven metal storage cabinets located on a paved area to the south of the building. Chemicals include cleaning and lubricating compounds, paints, and adhesives. Many of these materials are classified as corrosive or flammable materials. The waste storage and management practices appeared good.

The weapons storage bunkers are south of Building 524. Liquid fuels in the weapons include Otto fuel, JP-10, and TH Dimer (kerosene). The group of bunkers to the south have recently been reconstructed. A major part of this reconstruction involved removal of structurally unsuitable soil from the site. The materials removed appear to be dredge spoils from the Thames River deposited in the wetland. Prior to offsite disposal, these materials and excavation sidewalls and ground water were tested. The following samples were collected: one sample of ground water from within the excavation; two soil samples from excavation sidewalk (one above and one below the water table); and four from a stockpile of the excavated sediments. No information is available regarding the exact location of these samples. The results of this testing are included as Appendix B and summarized in Table 2-1. Total cyanide (0.8 and 0.96 ppm), petroleum hydrocarbons (82 and 90 ppm) and various metals were detected. No VOCs, PAHs, PCBs or DDT were detected.

Based upon present activities performed at this site, there is no apparent source for the cyanide and PAH contamination detected in the drainage swale during the Phase I RI.

The Navy plans to build more magazines and bunkers in this area within ten years.

2.4.1.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the Phase I RI and interpretation of the 1967 USGS Bedrock Geology Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map. An overview of the bedrock geology and hydrology of Area A is provided followed by site-specific descriptions of geologic conditions.

The 1967 USGS Bedrock Geology Map indicates that the bedrock underlying the majority of Area A is the biotite-quartz-feldspar gneiss of the Mamacoke Formation. The map indicates that all of the Area A Landfill and OBDA, the southern portion of the Area A Wetland, and the northern and eastern portions of the Area A Downstream are underlain by bedrock of the Mamacoke Formation. The northernmost portion of the wetland is underlain by a gneissic biotite granite that is mapped as the Potter Hill Granitic Gneiss. The southwestern portion of the Area A Downstream is mapped as an equigranular gneissic granite known as the Hope Valley Alaskite Gneiss.

Bedrock cores were drilled at four monitoring well locations in Area A. The bedrock at all four coring locations is mapped as the Mamacoke Formation, and the mineralogy and texture of the bedrock cores is generally consistent with that of the biotite-quartz-feldspar gneiss of the Mamacoke Formation.

Eleven overburden monitoring wells and 17 bedrock monitoring wells were installed in the Area A Landfill, Wetland, Downstream, and the Over Bank Disposal Area. The highest ground water elevation was measured in the middle of the Area A Landfill. It appears that ground water in the central-eastern portion of Area A flows north toward the Area A Wetland, and ground water in the northwestern portion of the Area A Landfill flows northwest toward the Area A Downstream and eventually to the Thames River. Ground water elevation data also indicate that ground water from the overburden aquifer is probably discharging into North Lake. Bedrock ground water does not appear to be discharging into the lake.

Slug displacement test data from six overburden wells were analyzed in order to estimate the *in situ* hydraulic conductivity of the overburden materials throughout Area A. The geometric mean of the hydraulic conductivity in the fill material and the dredge spoil combined was calculated to be 3.2 feet/day. The hydraulic conductivity of the dredge spoil was calculated to be 1.0 foot/day. The hydraulic conductivity of the sand, gravel and silt material surrounding a well in the Downstream area was calculated to be 6.8 feet/day. Slug displacement tests conducted in Area A bedrock wells provided a wide range of transmissivity values, indicating

TABLE 2-1 WEAPONS CENTER SUMMARY OF TEST RESULTS (all results in ppm)							
Constituent	**Sample Identification/Media**						
	Below Grade[1]	**Above Table[1]**	**Below Table[1]**	**620**	**621**	**622**	**623**
	Ground Water	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
Cyanide (total)	ND	0.80	0.96				
Cyanide (reactive)	NA	ND	ND	ND	ND	ND	ND
VOC (Method 8020)	NA	ND	ND	ND	ND	ND	ND
PAH	NA	NA	NA	ND	ND	ND	ND
TPH	NA	82	90	NA	NA	NA	NA
PCB	NA	ND	ND	ND	ND	ND	ND
DDT	NA	ND	ND	ND	ND	ND	ND
Total Metals							
Arsenic	NA	ND	0.044	NA	NA	NA	NA
Barium	NA	54	125	NA	NA	NA	NA
Cadmium	NA	ND	0.51	NA	NA	NA	NA
Chromium	NA	10.5	15.1	NA	NA	NA	NA
Lead	NA	32.2	16.3	NA	NA	NA	NA
Mercury	NA	0.039	0.047	NA	NA	NA	NA
Selenium	NA	ND	ND	NA	NA	NA	NA
Silver	NA	3.1	4.8	NA	NA	NA	NA
TCLP Metals							
Arsenic	NA	ND	ND	0.004	ND	ND	ND
Barium	NA	0.21	0.23	0.14	0.05	0.13	0.31
Cadmium	NA	ND	ND	ND	ND	ND	ND
Chromium	NA	ND	ND	0.02	0.01	0.03	0.03
Lead	NA	0.06	0.04	0.11	0.13	0.09	0.02
Mercury	NA	ND	ND	0.003	ND	ND	ND
Selenium	NA	ND	ND	ND	ND	ND	ND
Silver	NA	ND	ND	ND	ND	ND	ND
1. Sample identifications indicate position of sample with respect to water table.							

high variability of transmissive properties within the fractured bedrock below the site. The velocity of ground water flow through sediments in the landfill and wetland portions of Area A was estimated to be 0.04 feet/day. The ground water flow velocity through the soils in the Area A Downstream was estimated to be 0.02 feet/day.

Area A Landfill: The 1983 SCS Soils Map shows most of the Area A Landfill as Udorthents-Urban Land. The southwestern portion of the Landfill (which also includes the CBU Drum Storage Area and the Rubble Fill at Bunker A-86) is classified as Hollis-Charlton Rock, 15-45 percent slopes. Both classifications are generally consistent with the soils and topography observed adjacent to the Area A Landfill.

The 1960 USGS Surficial Geology Map shows non-stratified drift in the Area A Landfill. This classification is consistent with soils observed below fill material and dredge spoil in the eastern portion of the landfill and soils at the surface in the western portion of the landfill, the CBU Drum Storage Area and the Rubble Fill at Bunker A-86.

The Area A Landfill is underlain by 10 to 20 feet of miscellaneous fill material, which is generally underlain by 10 to 20 feet of dredge spoil. On the southwestern side, fill material is underlain by compact sand, silt, and gravel which extend down to bedrock.

Area A Wetland: The 1983 SCS Soils Map depicts the Area A Wetland as Udorthents-Urban Land. This classification is consistent with conditions observed during the field investigation.

The 1960 USGS Surficial Geology Map shows the Area A Wetland as a swamp overlying non-stratified drift (till) and alluvium (western portion of the present wetland). This classification generally agrees with observed site conditions and historical information about the site. However, the presence of alluvium and non-stratified drift below the artificial fill in the wetland was not completely documented as part of the soils investigation. The omission of artificial fill in the wetland portion of the map suggests that the area was mapped prior to or during the time that the dredge and fill operation was in progress.

The Phase I RI indicates that the surface of the Area A Wetland is covered with a 2-foot layer of roots and plant fragments. This is underlain by dredge spoil consisting of silt and clay with traces of fine-grained sand and shell fragments. Where dredge spoil does not lie directly on bedrock, it is underlain by a thin remanent of topsoil, which is itself underlain by sands and gravel. Dredge spoil is 25 to 35 feet thick on the south side of the wetland and 10 to 15 feet thick on the north-northeast side of the wetland.

Area A Downstream/OBDA: The 1983 SCS Soils Map depicts the Area A Downstream as Udorthents-Urban Land to the north and west of North Lake. The portion of the Downstream between the earthen dike and North Lake is depicted as Hollis-Charlton Rock, 3 to 15 percent slopes. Both classifications are consistent with observed soil conditions, topography and development in this area. OBDA is also shown as Hollis-Charlton Rock, 15 to 45 percent slopes. This classification is consistent with observed site soil conditions and topography.

The 1960 USGS Surficial Geology Map shows alluvium along the downstream watercourses from (and including) OBDA to North Lake. The area is mapped as Thames River terrace deposits from North Lake west to the Thames River. All classifications are generally consistent with observed soil conditions in the specified areas.

The Area A Downstream and OBDA are physically separated from the Area A Wetland by an earthen dike and from the Area A Landfill by a steep slope. No evidence of fill material was observed in the Area A Downstream or OBDA. Unconsolidated material at the bottom of the slope consists of fine-grained sand and silt with rust-colored mottling. Similar soils were observed at 2DMW10 and in borings at the Torpedo Shops to the north. The sediments at 3MW12 consist of yellow and brown, mottled, fine-grained sand, silt and clay overlying fine- to medium-grained sand and gravel. Based on the sediments found in this area and the mapped surficial deposits in the vicinity, it is likely that these are alluvial deposits from either the present stream system or one that existed prior to the construction of the earthen dike.

Weapons Center: The Weapons Center is located over a former section of the wetlands. The geology and hydrology of the wetlands are discussed above.

2.4.1.3 Nature and Extent of Contamination

Area A Landfill - Nature and Extent of Soil Contamination: Radiation, geophysical and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey detected VOCs, predominantly petroleum hydrocarbons, in the deployed parking area.

VOC concentrations in the subsurface soil within the Area A Landfill were generally low. No TBC values for VOCs in soil samples were exceeded. One surface soil sample collected near the concrete storage pad did contain elevated levels of petroleum hydrocarbons. SVOCs, principally PAHs, were detected at relatively low levels in several landfill subsurface soil samples. The results of the SVOCs analyses at the Area A Landfill were significantly lower than at the DRMO and Goss Cove former landfill sites. The organic results, in general, do not indicate significant disposal of organic chemicals within the Area A Landfill.

No PCBs were detected in the subsurface soils within the Area A Landfill. One surface soil sample contained PCBs above the TBC concentration of 10,000 ppb. This soil sample was collected adjacent to the concrete storage pad where drums, PCB transformers, and electric switches were once stored. Based on the two surface soil sample locations, the extent of the PCBs in this area was not defined.

Pesticides were detected at three subsurface sample locations (2LMW7S, 2LMW8S, and 2LMW18S) at the Area A Landfill. DDTR was detected at these locations at relatively low concentrations below TBC values. DDT was present above the TBC value of 500 ppb at one surface soil sample near the concrete storage pad.

Of the 12 subsurface samples analyzed by TCLP, ten contained one or more metals exceeding TBC values. Metals exceeding TBC values included arsenic, cadmium, lead, and selenium. TCLP hazardous waste characteristic values were not exceeded for any samples. Several inorganic constituents (including beryllium, cadmium, lead, and mercury) exceeded established background levels based on mass analysis. Other inorganics exceeding background levels included copper, nickel and boron. The majority of these elevated inorganics are probably related to past landfill disposal.

The lead and cadmium values are generally low and are not indicative of the existence of a major source, such as the historical battery acid disposal reported in this area. Levels of cadmium, and particularly lead, were much higher at the Spent Acid Storage and Disposal Area and DRMO, where battery acid storage tanks existed.

Area A Wetland - Nature and Extent of Soil and Sediment Contamination: VOC concentrations in the subsurface soil and sediment within the Area A Wetland are in the low to moderate range. VOCs are generally distributed throughout the wetland area and present at uniform concentrations at depth. This is consistent with the Thames River dredge materials deposited in the wetland. VOC TBC values exceeded included benzene (one sample), trichloroethene (three samples) and tetrachloroethene (four samples). The source of the VOCs in the wetland subsurface soils appears to be associated with sediments from the Thames River and/or absorption of ground water chemicals onto the sediments. The origin of the VOCs in the sediments could be from several sources, including those mentioned above, runoff from the Weapons Center, and general urban runoff. The samples collected near the landfill did not contain any VOCs above TBC values.

SVOCs, principally PAHs, were detected at generally low levels in most of the wetland sediment and subsurface soil samples. Overall, SVOC concentrations were slightly higher in the 0-2 and 10-22 foot depth intervals, although this may be attributable to the smaller number of samples collected in the 2-10 foot interval. Sediment samples recently collected from the Thames River also contain low levels of PAHs, consistent with the levels in the Area A Wetland.

PCBs (Aroclor 1260) were detected at two sample locations, but were below TBC values. The source of the PCBs in the wetland near the landfill appears related to transport of contaminated surface soils from the Area A Landfill.

Pesticides (DDTR) were detected at five sample locations in the 0-2 foot depth interval. Based on detection in the 0-2 foot interval, these appear to be related to the past surface application of pesticides at the wetland area. The pesticide detections were less frequent and the concentrations much lower than in samples from the Area A Downstream. This may be related to the potential for higher concentrations of pesticides present at locations not sampled (pesticide bricks were reportedly applied at point locations) and/or due to compositing of the samples. Previous sediment sampling conducted within the wetland near its outlet and at an upgradient location (east side) contained DDTR in the 17,000 ppb range. Alternatively, more substantial application of pesticides may have occurred in the Area A Downstream.

In general, metal concentrations within the wetland subsurface soil and sediment samples were low. A total of 35 soil and sediment samples were collected within the wetland proper, with the remainder collected at adjacent locations. Several samples contained slightly elevated levels of lead (7), mercury (3), cadmium (1), and silver (2). Several samples exceeded TBC values based on TCLP extraction. These metals include arsenic, cadmium, chromium, lead, selenium, and silver. Only two samples contained metals (lead, silver) which exceeded both established background concentrations and TBC values based on TCLP analysis. The elevated metals are probably associated with sediment originating from the Thames River.

Area A Downstream/OBDA - Nature and Extent of Soil and Sediment Contamination: The subsurface soil samples were collected at well locations in wooded undeveloped areas where no past disposal was reported or apparent. The exception was 3MW12S, which was located adjacent to the wetland at OBDA, where past disposal occurred.

Trichloroethene (24 ppb) and tetrachloroethene (58 pp) were detected at a subsurface soil sample location near North Lake, both above TBC values of 5 ppb. Low levels of toluene and 1,1-dichloroethene were also detected. The source of the solvents detected near North Lake is unknown. One possibility is an unconfirmed report from a retired Navy employee who stated that there was a past disposal area in this general vicinity. This could not be confirmed based on review of aerial photographs and discussions with other Navy personnel.

No SVOCs were detected in subsurface soils, except for low levels of phthalates at one sample location. Low levels of SVOCs, principally PAHs, were present in a subsurface soil sample at OBDA, which correlates with SVOCs detected in the sediment samples at OBDA.

No PCBs were detected in the subsurface samples. Pesticides, including DDT and its derivatives, were detected in a subsurface soil sample near OBDA and at a sample near North Lake. The detection of pesticides at these locations appears related to past pesticide application in Area A. No significant detections of inorganics were noted in the subsurface soil samples.

Twenty-three sediment samples were collected for analysis from the OBDA wetland, the Area A Downstream and associated ponds, and North Lake. The purpose of the sediment sampling and analysis programs was to assess the extent of sediment contamination (principally pesticides) within this area, due to past application and sediment transport from potential source areas. Previous analysis of sediments in this area indicated the presence of pesticides and metals.

No VOCs were detected above TBC values for sediment samples collected. At sample locations near the outlet of the Area A Wetland, low levels of VOCs (methylene chloride, trichloroethene) were detected, indicating some limited migration of VOCs via sediment transport from the Area A Wetland. Within OBDA, all sediment samples contained low levels of VOCs, but below TBC values. VOCs detected include methylene chloride, 2-butanone (methyl ethyl ketone), tetrachloroethene, toluene, ethylbenzene, and xylene. This indicates that past releases of solvents and petroleum hydrocarbons occurred at the OBDA site. These VOCs could also be partially attributable to adsorption of chemicals to the sediments from ground water. Low to moderate levels of SVOCs were detected in most sediment samples.

The only detection of PCBs was at 2DSD12, at the outlet of the Downstream watercourse to the Thames River, adjacent to DRMO. Based on the elevated levels of PCBs at the DRMO site, it appears likely that this is associated with surface water runoff from the DRMO site and not Area A.

Pesticides (DDTR) were detected at moderate to very high concentrations within the Area A Downstream watercourses and ponds. No pesticides were detected in the North Lake sediments. TBC values were exceeded at 10 of the 23 sample locations. The highest concentrations were detected in the two ponds below the Area A dike and within the OBDA sediments. This may be due to pesticide application rather than sediment transport, since these concentrations were much higher than those found within the Area A Wetland. Lower concentrations downstream of these areas and extending to the Thames River are attributable to sediment transport from the higher concentration areas. The data indicate that ongoing migration of pesticides to the Thames River is occurring via sediment transport from the pond source areas.

Several metals were detected above established background levels. These occur in samples closest to the Area A Wetland. Metals detected included beryllium, cadmium, lead, selenium, zinc, and boron. Since cadmium was not detected above background levels in the Area A Wetland sediments, the cadmium does not appear to be related to sediment transport from the wetland. No metals were detected above background levels in North Lake sediments.

Ten sediment samples were collected from the OBDA area. Sediment samples contained metals above established background levels for cadmium (3), iron (2), lead (4), selenium (2), and zinc (2). Cadmium results based on TCLP analysis correlated with mass weight analysis for two samples. TCLP analysis detected no lead. The elevated iron concentration may partially explain the rust colored leachate that is visible in this wetland area and within the stream bed. The lead and cadmium may suggest battery/battery acid disposal in this area, where the highest concentrations throughout Area A were recorded. Alternately, cadmium present in the ground water could have adsorbed onto sediments while discharging to OBDA.

Area A - Nature and Extent of Ground Water Contamination: Twenty-eight ground water monitoring wells were installed and sampled within Area A, which includes the Landfill, Wetland, and Downstream areas. Eleven were overburden wells and 17 were bedrock wells.

VOCs were detected in only six of 28 monitoring wells within Area A. TBC/ARAR values for drinking water were exceeded at only three locations. Trichloroethene was detected above ARARs at 2LMW13D (10 ppb) at the west end of the landfill, and 2DMW16D (17 ppb) upgradient of North Lake. These are both bedrock wells. This suggests a low concentration plume of solvents within the bedrock aquifer extends from the western portion of the former landfill downgradient to the North Lake area. The plume appears to be fairly narrow, since no solvents were detected in the Area A Downstream wells to the north. This is supported by review of the ground water specific conductivity data which is used as a landfill leachate indicator. Solvents were not detected in downgradient well 3MW12D (OBDA), suggesting preferred fracture flow is occurring in the bedrock. However, this does not correlate with the cadmium data, which indicated elevated levels of cadmium at 2LMW13S and 3MW12D. The downgradient extent of the solvent plume is undefined, but ground water is flowing in a westerly direction. Benzene was detected at 10 ppb, above drinking water standards (5 ppb) at 2LMW18S, and may be related to parked vehicles in this area; it was not detected in any other well in Area A.

Overall, the VOC concentrations, where detected, were low, particularly given the historical use of Area A as a landfill. Although drinking water ARAR/TBC values were exceeded in three wells, the results do not indicate any significant ongoing release of VOC contaminants. Based on the soil gas and subsurface soil data, low levels of aromatic hydrocarbons and solvents are present throughout much of the Area A Landfill. This suggests a generally uniform, low level of soil contamination within the landfill and no definitive source area. The deployed parking area and adjacent area to the east (also used for automobile storage/parking) exhibited the most uniform level of petroleum hydrocarbons based on soil gas data.

PCBs were detected in the ground water at one location within the landfill. The concentration exceeded solubility and further sampling of the well would be required for confirmation of the result.

Cadmium was the only inorganic which exceeded primary drinking water standards (ARARs) within Area A. Cadmium was also detected in one instance above drinking water standards at a residential well located east of Area A. Cadmium was detected above the 5 ppb drinking water standard at 2LMW18D (7.2 ppb), 2WMW3D (7.7 ppb), 2WMW5S (6.4 ppb), 2WMW3S (10.6 ppb), 2LMW18S (29.1 ppb), 2LMW13D (44.8 ppb), and 3MW12D (16 ppb). The source of these elevated levels of cadmium may be related to soils within the landfill and, possibly, OBDA. However, cadmium soil concentrations in the landfill only exceeded established background levels at one sample location (2LMW8S). It is possible that higher concentrations of cadmium exist in the landfill, at locations other than the sample points. Dissolved cadmium levels in Area A ground water may be partially attributable to low pH values for some wells. The upward gradient within most of the landfill would minimize the transport of cadmium to the bedrock aquifer from a landfill source. However, at bedrock well 2LMW13D, where there is a strong upward gradient, cadmium is present in the bedrock either from a source upgradient within the landfill or another unknown upgradient source. The former Weapons Center is upgradient of this area along Wahoo Avenue; however, the absence of elevated levels of cadmium in other nearby bedrock wells (2LMW9D, 2LMW17D, and 2LMW14D) does not strongly support an offsite source, but rather a landfill source.

The overburden ground water flow in the central and eastern portions of the landfill is toward the wetland, and in the western portion of the landfill to the northwest and down the Downstream watercourse valley. The cadmium ground water contamination appears confined to the landfill and the OBDA area. Cadmium was only detected in well 3MW2D in the OBDA, suggesting restricted plume to the northwest. Due to preferred bedrock fracture flow patterns, other wells may not have intercepted the cadmium, and the cadmium plume may be undefined.

Of importance to this study is the direction of bedrock ground water flow in this area, due to the detection of cadmium in several offsite residential wells east of Route 12. Inspection of the bedrock ground water contour map indicates that the residential wells along Route 12, Baldwin Hill Road and North Pleasant Valley Road are upgradient of Area A, and would not be affected by conditions at the site. Most of these wells had bedrock ground water elevations substantially higher than wells containing cadmium in Area A (2WMW3D, elevation 76 feet). Residential wells near the NSB-NLON east gate, southeast of Area A, had bedrock water elevations (75-80 feet) in the same range as 2WMW3D, the closest bedrock well in Area A. Therefore, available data are insufficient to determine whether these wells are upgradient or downgradient of the western portion of the Area A Landfill. However, cadmium does not exceed drinking water standards in these wells.

Iron and manganese exceeded secondary drinking water standards in many Area A wells. The results for 2WMW1D and 2WMW2D (upgradient wells) and the residential wells were much lower for iron and manganese, which indicates a source of these inorganics within the Area A landfill material and wetland sediments.

Radiological screening parameters were exceeded in nine of the 20 samples: three within the Landfill area; one near the Weapons Center; and four within the Area A Downstream area. These elevated readings could be the result of naturally occurring radioisotopes which do not meet the gross screening criteria. Further sampling and analysis is required for confirmation.

Residential Well Analytical Results: A residential well sampling and analysis program was conducted to assess ground water quality in offsite areas near Area A.

The first round sampling indicated low levels of chloromethane, methylene chloride, and xylene at OSW15 (16 Sleepy Hollow Road), but below drinking water standards. This well was resampled for VOCs in the second round and none were detected. The first sampling round indicated the presence of cadmium at OSW6 (1458 Route 12) above primary drinking water standards (10 ppb) at a concentration of 26.3 ppb. Other compounds (iron, manganese, aluminum and sodium) were detected in other wells at levels exceeding secondary drinking water standards, and are attributable to natural ground water conditions.

Due to the presence of cadmium, second and third sampling rounds were conducted to expand the sampling program to areas east of Area A on Route 12, North Pleasant Valley Road, and Baldwin Hill Road. The second and third sampling rounds did not detect any metals above primary drinking water standards. Also, cadmium was not detected at 1458 Route 12, where it was previously present. Cadmium was detected at low levels at five of 13 wells sampled in the 2.1-3.1 ppb range, below the 10 ppb standard. As previously discussed, an assessment of the ground water hydrogeology of this area indicates that the presence of cadmium in the offsite residential wells is not attributable to the detection of cadmium within Area A at NSB-NLON and appears to be a natural background concentration in the ground water. One possible exception is well OS25 to the southeast, which contained cadmium below standards, but could be downgradient of the Area A Landfill. However, this Work Plan will further assess ground water flow at the Area A site to confirm these initial findings.

Boron was found in all residential wells above the TBC value of 600 ppb, which is based on an EPA health advisory; however, the validity of the initial three rounds of sampling data analyzed by N.E.T. Cambridge was found to be erroneous due to sulfur interference. Supplemental sampling conducted by the Navy and the CTDEP in August 1992 found boron levels well below the U.S. EPA health advisory. A separate Plan of Action to further evaluate boron will only be implemented if future sampling of residential homes surrounding the NSB-NLON detects elevated levels of boron.

Nature and Extent of Area A Surface Water Contamination: Fifteen surface water samples were collected within Area A, including the Wetland and Downstream areas and Thames River. These samples were collected to assess surface water quality.

Low levels of VOCs were detected in several samples (2DSW5, 2DSW7, 2DSW8, 2DSW12, and 2DSW13). Except for one sample, constituents detected are petroleum hydrocarbons and could be associated with runoff. One sample near Triton Avenue contained 3 ppb of tetrachloroethene and 2 ppb of styrene. No ARAR or TBC values were exceeded for the VOCs. No SVOCs were detected at any of the sampling locations.

No pesticides or PCBs were detected in any of the samples except for 2DSW4, which contained 1.9 ppb of DDD. This sample is from an area where high levels of DDTR, including DDD, were detected in sediments. It is likely that the origin of DDD in the surface water is from the sediments.

ARAR/TBC values for inorganics were exceeded at several sample locations for cadmium (3 of 15), copper (15 of 15), iron (11 of 15), lead (11 of 15), manganese (13 of 15), zinc (14 of 15), and mercury (1 of 15). These ARARs are based upon in-stream water quality criteria and standards to protect aquatic life, and may not be appropriate for the wetlands and small drainage streams. The presence of iron and manganese in surface water may be a result of the low pH and reducing conditions created by the Area A Landfill. Some of the iron and manganese may originate from wastes; however, the majority detected in surface water probably leached from native soils. Of note are the ARAR exceedances in the Thames River at sample locations 2DSW12 for manganese and iron, and at 2DWS13 for manganese. Area A upstream surface water samples also contained elevated levels of iron and manganese, whereas surface water samples in the Thames River at DRMO and Goss Cove did not contain levels above ARARs. The iron standard of 1000 ppb is based on chronic aquatic toxicity water quality criteria and the manganese standard is based on water quality criteria for human health risks from fish consumption.

Copper and zinc, which exceeded water quality criteria or standards, were also detected in concentrations above background levels in soils at the Area A Landfill. It is assumed that the elevated concentrations originate from the Area A Landfill.

Cadmium and lead are present above ARAR values and levels normally seen in natural surface waters are present in both the Area A Wetland and Landfill soils and sediments. The presence may be the result of historical disposal activities. However, cadmium and lead were also detected in the upgradient sample location (2LSW1) above ARAR values.

Mercury was only detected in one surface water sample (2DSW9). This location (adjacent to Triton Road) is immediately downgradient of two sediment sampling locations where mercury was found. Although the two sediment concentrations were below background, mercury was not detected in any other sediment sample. There was one occurrence of mercury above background concentrations in Area A Landfill soils. Mercury is rarely found in natural surface waters above 1 ppb. The source of the mercury in sediments is not apparent, although historical disposal in the Area A Landfill is one possible cause. However, it is more likely that a past release occurred upgradient of sample locations 2DSD7 and 2DSD8 along Triton Road. It is noted that sediment sample 7SD1, within a runoff swale from the Torpedo Shops, contained no mercury, nor did any other soil or ground water sample at the Torpedo Shops. This implies that the Torpedo Shops are not the source.

All of the radiological results were below ARAR screening values.

Weapons Center: SVOCs were detected in sediments during the Phase I RI within a drainage swale at a stormwater discharge location of the Weapons Center. The Verification Study sediment sampling of another stormwater culvert discharge location near the Weapons Center also indicated the presence of PAHs.

PCBs (Aroclor 1260) were also detected during the Phase I RI in sediments from a drainage swale, but were below TBC values. The source of the PCBs detected at the Weapons Center is unknown. Cyanide was also detected in sediment at the drainage outlet from the Weapons Center. The previous Verification Study also reported cyanide in sediment at another drainage culvert discharge location from the Weapons Center. The cyanide and elevated PAHs suggest a possible source of contamination at the Weapons Center. The elevated levels of cyanide and PAHs suggest that spent Otto fuel may be the cause of this contamination; however, the specific source is unknown.

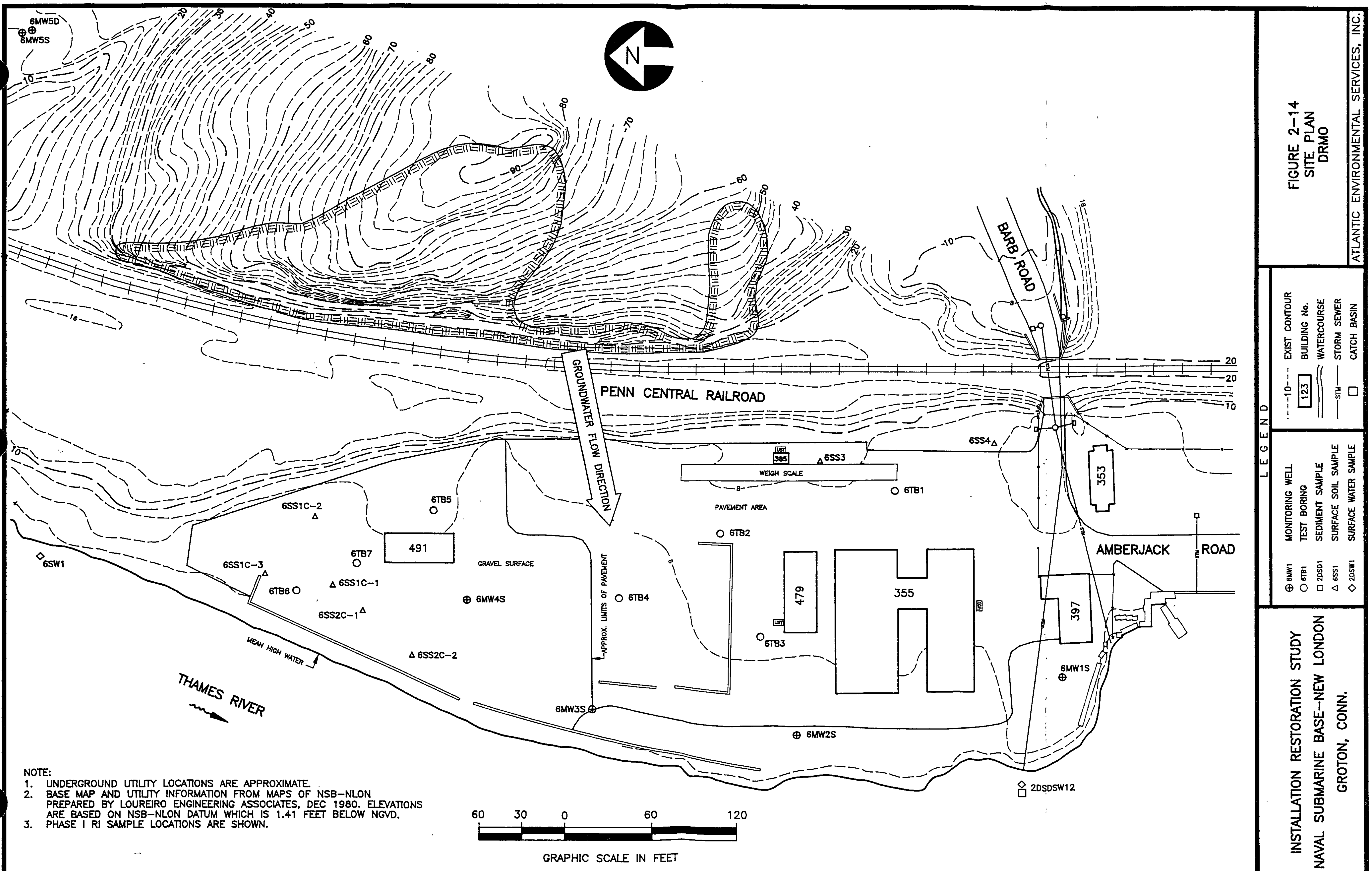
2.4.2 Defense Reutilization and Marketing Office (DRMO)

2.4.2.1 Site Background

The Defense Reutilization and Marketing Office (DRMO) site is adjacent to the Thames River in the northwest section of NSB-NLON. The DRMO is the storage and collection facility for items to be sold at auction sales held periodically through the year. Scrap metal is also temporarily stored prior to being transported off this site. A site plan of DRMO, which includes previous sample locations, is provided as Figure 2-14.

The DRMO site was used as a major base landfill and burning ground from 1950 to 1969. The materials burned and landfilled included construction materials, combustible scrap, and other non-salvageable waste items. These materials were reportedly burned on the shoreline and then disposed over the riverbank and partially covered. Also, a former battery acid handling facility was located adjacent to Building 491. An in-ground rubber-lined tank and associated pumping facilities were present, similar to the Spent Acid Storage and Disposal Area site.

DRMO operations at this site, after the closing of the landfill, include storage of various items, including submarine batteries, white goods, and empty drums.



N
GROUNDWATER FLOW DIRECTION
PENN CENTRAL RAILROAD
BARB ROAD
AMBERJACK ROAD
THAMES RIVER
MEAN HIGH WATER
APPROX. LIMITS OF PAVEMENT
GRAVEL SURFACE
PAVEMENT AREA
WEIGH SCALE
491
479
355
397
353
385
6MW5D
6MW5S
6MW1S
6MW2S
6MW3S
6MW4S
6TB1
6TB2
6TB3
6TB4
6TB5
6TB6
6TB7
6SS1C-1
6SS1C-2
6SS1C-3
6SS2C-1
6SS2C-2
6SS3
6SS4
6SW1
2DSDSW12
NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
60 30 0 60 120
GRAPHIC SCALE IN FEET
LEGEND
6MW1 MONITORING WELL
6TB1 TEST BORING
2DSD1 SEDIMENT SAMPLE
6SS1 SURFACE SOIL SAMPLE
2DSW1 SURFACE WATER SAMPLE
--10-- EXIST CONTOUR
123 BUILDING No.
WATERCOURSE
STM STORM SEWER
CATCH BASIN
ATLANTIC ENVIRONMENTAL SERVICES, INC.
FIGURE 2-14
SITE PLAN
DRMO
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

Other routine grading and minor excavation occurs in the northern portion of the site. Future plans for this site include the construction of a Conforming Storage Facility for the temporary storage of hazardous waste generated at NSB-NLON.

2.4.2.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined based on the Phase I RI and interpretation of the 1967 USGS Bedrock Geology Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geologic Map shows the DRMO site as artificial fill underlain by a biotite-quartz-feldspar gneiss of the Mamacoke Formation. The northernmost portion of the DRMO is mapped as a gneissic biotite granite known as the Potter Hill Granitic Gneiss. An outcrop of the Westerly Granite is also mapped on the east side of the DRMO site. Field observations of fill material and bedrock outcrops are generally consistent with mapped classifications, although the Westerly Granite was not positively identified in the field. Bedrock was encountered northeast of the DRMO site (6MW5D) at a depth of 25 feet below grade. Twenty feet of bedrock was cored at this location. The mineralogy and texture of the core sample is consistent with that described as the Potter Hill Granitic Gneiss. Weathered and partially covered bedrock outcrops were present on the east side of the DRMO site adjacent to the railroad tracks. In addition, a prominent bedrock cliff is located to the east of both the DRMO site and railroad tracks.

The 1983 SCS Soils Map depicts the DRMO site as Udorthents-Urban land on the portion of the site that is adjacent to the Thames River and Hinckley Sandy Loam on the northernmost portion of the site. The 1960 USGS Surficial Geology Map shows artificial fill in the portion of the DRMO that is adjacent to the Thames River and terrace deposits of the Thames River in the northern portion of the DRMO. The classifications of Udorthents-Urban land and artificial fill are consistent with the past and present conditions on the southern portion of the DRMO site. Subsurface soil sampling data from the northern portion of the DRMO site is consistent with the description of Hinckley Sandy Loam provided by the SCS. Soils observed at the northern portion of the DRMO site are consistent with a coarse fraction of the terrace deposits.

DRMO is underlain by between 5 and 20 feet of miscellaneous fill (predominantly sand and gravel) material. Fill material is thickest in the northern portion of the site adjacent to Building 491, measuring up to 15 feet thick (at 6MW4). The sand and gravel is underlain by sand and silt that contains shell fragments.

In the southern portion of the site, fill material overlies sand, silt and clay. Shell fragments were observed in all borings in the southern portion except 6MW1. Shell fragments in fine-grained soils are probably representative of the original riverbed. Depth to fine-grained soils ranges from 10 feet in the central portion of the site to 20 feet in the northern portion.

Four overburden monitoring wells and one bedrock monitoring well were installed at DRMO. Ground water elevations in the overburden aquifer were approximately 4 to 6 feet below grade in the southern portion of DRMO and approximately 12 feet below grade in the north portion of DRMO. Water level measurements taken at the five overburden monitoring wells indicate that ground water flow is toward the west. As with other sites adjacent to the Thames River, ground water flow at DRMO is influenced by tidal fluctuations.

Slug displacement tests were conducted in two overburden wells and single well pumping tests were conducted in one overburden well and one bedrock well. Using data from these tests, the volume of water discharged from the overburden to the Thames River is estimated to be approximately 23,100 cubic feet per day (172,800 gpd), based on a flow velocity of 0.7 feet per day, a saturated thickness of 50 feet and a 660-foot section perpendicular to the flow path. It is noted that flow to the river is probably greater during low tide.

Data analyses indicate that the transmissivity of the bedrock in the vicinity of this well is 1,670 square feet per day, assuming a porous aquifer thickness of 150 feet.

2.4.2.3 Nature and Extent of Contamination

Radiation, geophysical and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining VOCs in several areas.

Twenty-four soil samples were collected from 12 test boring/monitoring well locations. Four surface soil samples and six ground water samples were collected. These samples were analyzed to define the nature and extent of contamination at the former landfill site.

VOC concentrations in soil at DRMO were generally low. However, elevated VOCs were detected at 6TB4 (6-8'), where the following was found: vinyl chloride (1,300 ppb), trichloroethene (20,000 ppb), and tetrachloroethene (210 ppb). The contamination appears to be generally isolated at the site based on results of the soil gas survey and other soil samples collected in this area.

SVOCs were present in most samples collected in the former landfill area. The SVOCs predominantly consisted of PAH compounds, many of which were at elevated levels. The spatial density of the sample locations indicates that PAHs are likely present throughout the DRMO site limits. Based on the former use of the site as a landfill, and an area where material was burned, the PAHs are probably a result of incomplete combustion and, perhaps to a lesser degree, due to petroleum releases.

PCB Aroclor 1260 is present at almost all sample locations except 6MW5S (background), and 6MW1S and 6MW2S (rear of office and storage building). Concentrations range from 52 ppb to 12,000 ppb. It is generally present in both the 0-2 foot and 2-6 foot depths. The presence of PCBs at this site is most likely associated with scrap metal storage (e.g., white goods), associated capacitor leaks and past storage of transformers. It is not necessarily due to landfill disposal. PCB Aroclor 1260 was also detected at sediment sample location 2DSD12, at the outfall of the storm drainage system from Area A, to the rear of Building 397 at DRMO. It was not present in other upgradient sample points along the Area A Downstream and may be a result of surface soil transport via surface water runoff from DRMO.

Pesticides were detected at one sample location at elevated concentrations; pesticides were detected at no other sample locations. Total pesticide concentrations were 57,800 ppb, consisting of DDT, DDD and DDE. The DDT concentration was above the TBC value. Due to pesticide detection at only one sample location and at a depth of 2-6 feet, it was likely associated with past landfilling rather than surficial application.

Out of 24 samples analyzed for TCLP metals, 21 contained one or more metals exceeding TBC values. Metals exceeding TBC values included barium, cadmium, chromium, lead, mercury and silver. TCLP hazardous waste characteristic values were exceeded for lead (5 ppm) at 6MW3S (2-4') (52 ppm), at 6TB5 (2-6') (32 ppm), and at 6SS3 (0-0.5') (6.2 ppm). Lead levels were generally elevated around Building 491 (former battery acid handling), indicating that battery acid releases occurred in this area. Many inorganic constituents exceeded established background levels based on mass analysis. These included antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, zinc and boron. The majority of these elevated levels are likely related to a combination of past landfill disposal and scrap metal storage.

No petroleum hydrocarbons were detected in the ground water samples. Trichloroethene and 1,2 dichloroethene were present in three downgradient wells (6MW2S, 6MW3S, and 6MW4S). Trichloroethene exceeded the ARAR value (5 ppb) with a concentration of 8 ppb at well 6MW4S. The primary source of the solvents in the ground water, based on the soil analytical results and the soil gas data, is projected to be in the area of 6TB4, 6MW4S, 6TB6 and 6TB7.

No SVOCs, PAHs, pesticides or PCBs were detected in any wells at the DRMO site. Low levels of phthalates and benzoic acid were detected in the upgradient well 6MW5D. The inorganic ground water analysis results indicate that selenium exceeds the primary drinking water standards (ARARs) at wells 6MW2S, 6MW3S, and 6MW4S. The cause of the elevated selenium levels in the ground water is unclear, but appears to be site related. Radiological screening values for gross beta were exceeded in two of the ground water sampling locations. The elevated readings could be the result of naturally occurring radioisotopes which do not meet the regulatory screening criteria, but further analysis is required for confirmation.

No VOCs, SVOCs, pesticides, or PCBs were detected in the upgradient surface water sample. Comparison of the inorganic results for this sample with the downgradient water sample (Goss Cove) did not suggest any detectable impact on the Thames River from NSB-NLON based on this limited data.

2.4.3 Lower Subase

2.4.3.1 Site Background

The Lower Subase is located along the western edge of NSB-NLON, adjacent to the Thames River. It is bound by the Thames River to the west and by the Penn Central Railroad to the east. The Lower Subase is the original subase, and its history dates back to 1867. Most of the construction took place in the early 1900s with major expansion between 1935 and 1945. Extensive portions of this area have been filled. The Lower Subase has always been used for operations and maintenance. Those functions typically generated industrial and hazardous wastes such as petroleum oils and cleaning solvents. Two sets of concrete underground storage tanks (USTs) are also located at the Lower Subase at the northern end of the study area. Four USTs are located just north of the powerhouse, and seven USTs are located just south of Building 107. In addition, there is an extensive underground fuel oil and diesel oil distribution system at the Lower Subase. A site plan of the Lower Subase, which includes previous sampling locations, is provided as Figure 2-15.

Previous investigations (NESO 1979, Wehran 1987) have identified subsurface oil contamination associated with both sets of USTs, a waste oil pit in Building 79 where diesel train engines were serviced, and the underground fuel oil distribution system.

The Navy has implemented a major program to replace these underground tanks and the fuel oil distribution system. Of the ten concrete USTs, six now serve as spill containment for new steel tanks, three have been properly abandoned, and one is out-of-service. The Navy, while retrofitting or abandoning these tanks, did not detect any major structural defects or cracks. The underground No. 6 oil lines will be abandoned in the future based upon present Navy plans. All of the subsurface No. 2 oil lines were replaced or installed in 1980.

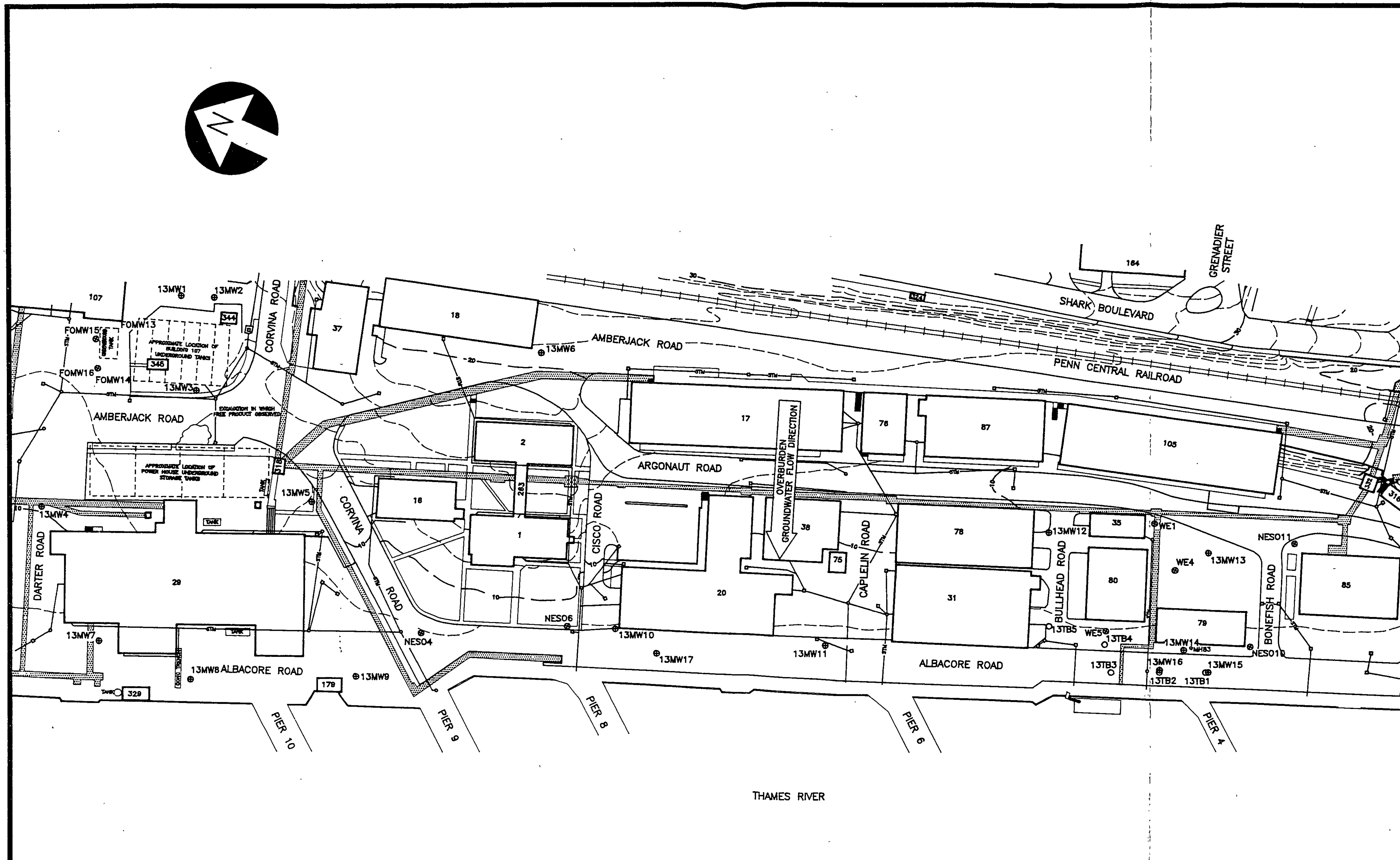
2.4.3.2 Site-Specific Geology and Hydrogeology

Site-specific geology has been determined based on the Phase I RI and interpretation of the 1967 USGS Bedrock Geology Map, the 1983 SCS Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geology Map shows that the Lower Subase is underlain by a biotite-quartz-feldspar gneiss of the Mamacoke Formation. No bedrock outcrops were observed in the Lower Subase site and no bedrock was encountered during the installation of monitoring wells and test borings.

The 1983 SCS Soils Map depicts the Lower Subase site as urban land. This classification is consistent with the present site development. The 1960 USGS Surficial Geology Map depicts the surficial deposits at the Lower Subase as artificial fill. This classification is consistent with information obtained during the installation of test borings and monitoring wells.

Data collected during the Phase I RI indicates that the Lower Subase is underlain by a layer of sand and gravel which is 10 to 20 feet thick on the west side of the Lower Subase and 10 to 15 feet thick on the east side. The sand and gravel layer is underlain by a layer of fine sand and silt with shell fragments, which is thickest on the west side of the site and pinches out to the east. The maximum thickness of this unit is not known, as the bottom was not encountered in any of the borings on the west side of the site. On the east side of the site, the sand and gravel layer is underlain by fine- to medium-grained sand. As previously discussed, the Lower Subase is largely constructed on fill material; the sand and gravel layer observed in the soil borings is probably a layer of artificial fill underlain by river-bottom sediments.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB–NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB–NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

100 50 0 100 200

GRAPHIC SCALE IN FEET

FIGURE 2–15
SITE PLAN
LOWER SUBASE

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

—10—	EXISTING CONTOUR
123	BUILDING NUMBER
o MH73	EXISTING MANHOLE
	UNDERGROUND UTILITY TRENCH
—STM—	STORM SEWER
□	CATCH BASIN
⊕ 6MW1	MONITORING WELL
○ 6TB1	TEST BORING
□ 2DS01	SEDIMENT SAMPLE
△ 6SS1	SURFACE SOIL SAMPLE
◇ 2DSW1	SURFACE WATER SAMPLE

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

Seventeen ground water monitoring wells screened in the overburden were installed in the Lower Subase. Seven additional wells installed during previous environmental investigations were also used for this investigation. At low tide, ground water flows west toward the Thames River. At high tide, ground water flows east from the river in the western portion of the site and flows west toward the river in the eastern portion of the site. Thus, a small portion of the overburden aquifer at the Lower Subase ebbs and flows with the tide. This tidal effect diminishes with distance from the river, and therefore, reversal of ground water flow direction at high tide does not extend further than 300 feet inland.

Seven overburden wells were tested in the Lower Subase to evaluate *in situ* hydraulic conductivity of the overburden material. Review of the data indicates that the slug displacement test was ineffective in estimating the hydraulic conductivity of the material due to its high permeability. The hydraulic conductivity of the sediments is estimated to be 50 feet per day, based on published values (Freeze and Cherry 1979). The ground water flow velocity was calculated to be 1.3 feet per day. Assuming a saturated thickness of 50 feet, a flow velocity of 1.3 feet per day, and using the cross-sectional area of flow perpendicular to the flow direction, it was estimated that 88,000 cubic feet of water per day (658,240 gpd) discharges from the unconsolidated soils in the Lower Subase to the Thames River.

2.4.3.3 Nature and Extent of Contamination

To determine the extent and degree of contamination at the Lower Subase, investigations included the installation of 17 new wells and five soil borings. Soils from the five soil borings were field screened for contamination. Soil samples were collected for laboratory analysis from all monitoring well installations. Ground water from all 17 new wells and seven existing wells were sampled. All soil and ground water samples were analyzed for TCL volatile organics, TAL inorganics, total petroleum hydrocarbons, and fluorescence "fingerprint" analysis. In addition, soils were analyzed for TCLP metals.

The findings and conclusions of the investigations follow.

- Ground water at the Lower Subase is relatively clean with only slight exceedances of ARAR values at six locations. VOC standards were exceeded at 13MW2 and 13MW13, and metal standards were exceeded at 13MW8, 13MW9, NESO10 and NESO11.

- No free product was detected in the subsurface, other than very thin layers in 13MW5 and MH83. No oil releases were observed along the bulkhead at the Thames River.

- A large area of subsurface soil near Building 29 contains petroleum hydrocarbons which apparently originate from both sets of underground storage tanks. Although petroleum contamination is evident, no ARAR/TBC values for soils are exceeded.

- Ground water near Building 29 had a pH ranging from 9-11. This high pH is indicative of an ongoing release and is apparently due to the discharge of boiler blowdown to the subsurface.

- A smaller area of subsurface soil adjacent to Building 79 contains petroleum oils and low levels of organic solvent. TBC values for organics are only slightly exceeded at one sample location, 13MW13. The apparent source of this contamination is the former onsite oil pit in Building 79.

- Low levels of petroleum products are ubiquitous in the Lower Subase soils and ground water. The apparent source of this contamination is the accumulation over the years of minor spills and leaks.

- Elevated lead levels in soils were detected in several locations scattered across the site. Of these, two locations had TCLP lead levels high enough to classify the soils as a hazardous waste (13MW11 and 13MW15). The lead contamination may have resulted from former lead-acid battery management operations that used to be performed at the Lower Subase. Lead was not detected in ground water above ARAR values.

- The subsurface free product detected in previous studies is no longer present. It is concluded that some of this oil has migrated to the Thames River, and the remainder has been adsorbed to soils.

- Low levels of thallium were detected in ground water at wells 13MW15 and 13MW16.

3.0 SITE DYNAMICS

Detailed information regarding contaminant fate, transport and migration, including site-specific evaluations, can be found in the Phase I RI. Presented below is a summary of the site- and chemical-specific potential migration routes for each of the investigation sites. Conceptual site models are provided for each site which illustrate the potential contaminant transport and migration mechanisms and exposure route.

3.1 Supplemental Step I Investigations

3.1.1 CBU Drum Storage Area

Figure 3-5 includes a conceptual site model of Area A which shows the CBU Drum Storage Area and its relationship to Area A. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment are presented below.

This site consists of surface soils containing low levels of VOCs, SVOCs, TPH, 4,4 DDD, and lead. The apparent sources of the contamination (excluding 4,4 DDD) are containers which were temporarily stored at this location.

Air: The soils at this site are not covered with asphalt or other impervious materials and are only sparsely vegetated. Therefore, potential migration routes include transport by fugitive dust and volatilization followed by wind dispersion. VOCs are only present in low concentrations in surficial soils (less than 500 ppb) and are not considered to be significant regarding air migration.

Ground Water and Soils: The chemicals present in soils may migrate slowly with infiltrating precipitation and could enter the ground water. Based on an evaluation of ground water elevations measured at nearby locations in Area A, ground water flow is northeast toward Area A Wetland. VOCs tend to have high mobilities, while the mobility of 4,4 DDD and the SVOCs detected have low migration potential. Lead also detected at this site is generally relatively immobile; however, its mobility is dependent upon its chemical form and specification.

Surface Water and Sediments: Since this site is not covered, surface runoff could contain dissolved and suspended contaminants. Surface water flows as overland flow and discharges into Area A Wetland and partially infiltrates the Area A Landfill. Contaminants detected could be transported as both dissolved or suspended particles in runoff.

3.1.2 OBDANE

Figure 3-5 includes a conceptual site model of Area A which shows the OBDANE site and its relationship to Area A. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment are presented below.

This site consists of surface soils with low levels of tetrachloroethene. The apparent source of this contamination may be from empty containers and other miscellaneous debris discarded at this location.

Air: The soils at this site are not covered with asphalt or other impervious materials; however, the area is located in a wooded lowland area and is not likely to be subject to transport by fugitive dust. Tetrachloroethene is only present in low concentrations (2 ppb) and is not considered further in terms of its volatilization and potential wind dispersal.

Ground Water and Soils: The chemicals present in soils may migrate slowly with infiltrating precipitation and could enter the ground water. Based on an evaluation of ground water elevations measured at nearby locations in Area A, ground water flow is westerly and may discharge to surface waters in the Area A Downstream. Tetrachloroethene is moderately mobile; however, the concentrations detected to date do not indicate that this is a migration pathway of concern.

Surface Water and Sediments: Since this site is not covered, surface runoff could contain dissolved and suspended contaminants. Surface water flows to a low spot just downgradient of the site where it ponds, infiltrates, and eventually mixes with ground water. The concentration of tetrachloroethene detected during the Phase I investigations indicates that this is not a migration pathway of concern.

3.2 Step II Remedial Investigations

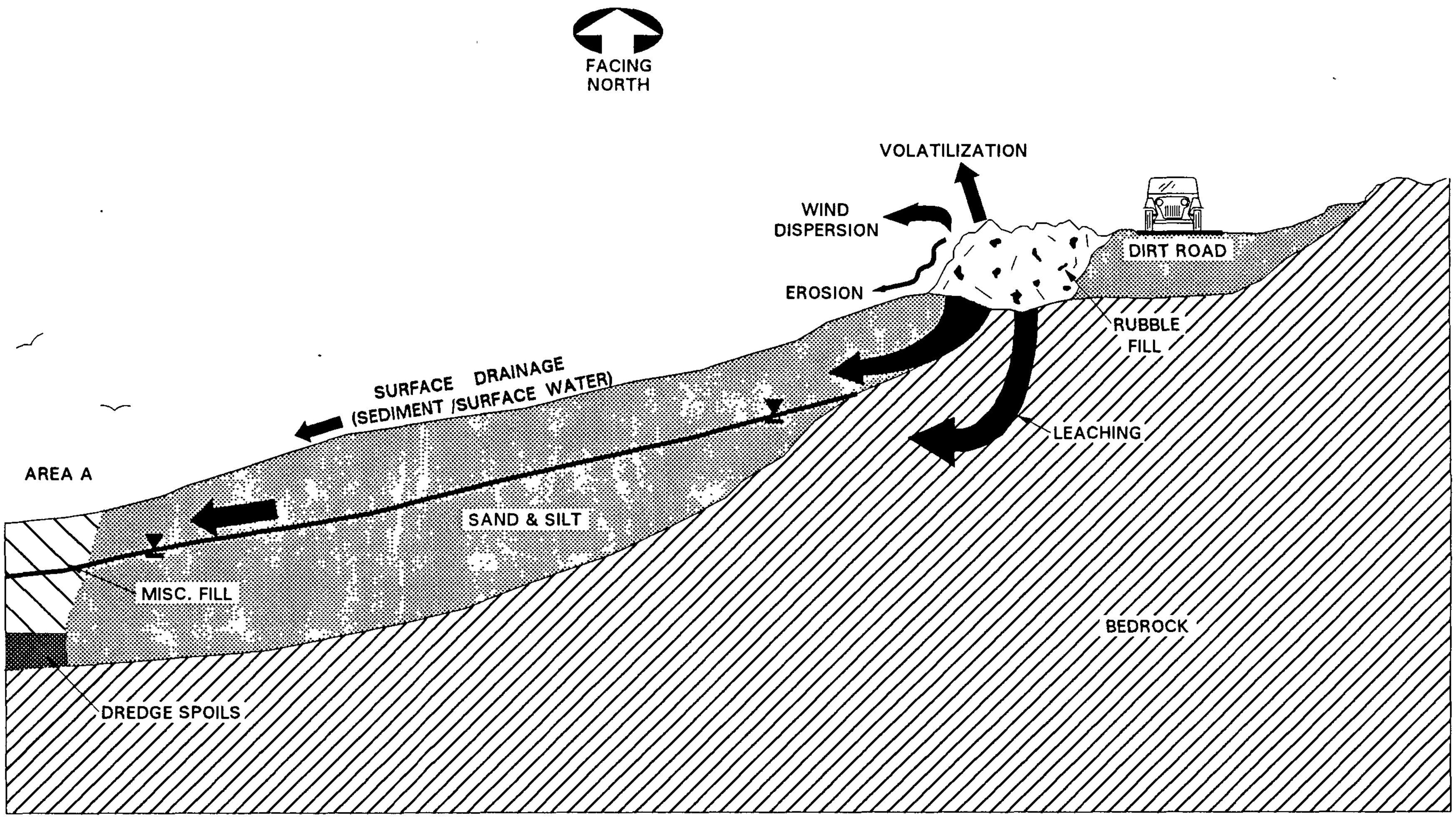
3.2.1 Rubble Fill at Bunker A-86

Figure 3-1 includes a conceptual site model of the Rubble Fill at Bunker A-86. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment is presented below.

Areas of concern at this site consist of surface soils with moderate levels of PAHs, low levels of pesticides, arsenic above background concentrations, and trace levels of VOCs. The one apparent source of contamination is the fill material discarded at the site. The source of the elevated levels of arsenic in surface soils is not known.

Air: The soils at this site are not covered with asphalt or other impervious materials and are only sparsely vegetated. Therefore, a potential migration route is transport by fugitive dust. VOCs are only present in trace concentrations and are not considered further.

Ground Water and Soils: The chemicals present in soils will migrate slowly with infiltrating precipitation and could enter the ground water. No ground water monitoring wells exist at this location to confirm ground water flow direction; however, ground water flow is probably northward toward Area A. The mobility of arsenic is dependent upon its chemical form (e.g., metal arsenides versus arsenic sulfides). Different arsenic compounds have medium to high mobilities. The pesticides and PCBs detected have a low mobility.



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INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-1
RUBBLE FILL AT BUNKER A-86
CONCEPTUAL SITE MODEL

ATLANTIC ENVIRONMENTAL SERVICES, INC.

Surface Water and Sediments: Since this site is not covered, surface runoff could contain dissolved and suspended contaminants. Surface water flows to the north as overland flow in a small drainage swale and discharges into Area A. Contaminants detected do not readily dissolve except for some arsenic compounds, and are transported primarily on suspended particles in runoff.

3.2.2 Torpedo Shops

Figure 3-2 is a conceptual model for the Torpedo Shops site. Presented below is a summary of the contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment. Releases have been detected in subsurface soils and ground water at the Torpedo Shops. Low concentrations of VOCs and SVOCs were detected in soils, along with antimony and silver concentrations above background. There was one occurrence each of PCBs and DDT in relatively low concentrations in soils. SVOCs, pesticides and PCBs were not detected in ground water. Several VOCs and antimony were detected in ground water. The potential sources of contamination at the site are former USTs and chemical storage areas near the Torpedo Shop buildings.

Air: Hazardous substances are not known or suspected to exist in surface soils and this area has a vegetative or asphalt cover. Therefore, transport by fugitive dust is not considered to be a significant migration route for soils. VOCs at low to moderate concentrations were present in subsurface soils and ground water. There are buildings within the current study area. If high levels of VOCs are detected in soils and ground water near the Torpedo Shops, then infiltration of VOCs into these buildings would be a potential contaminant migration route.

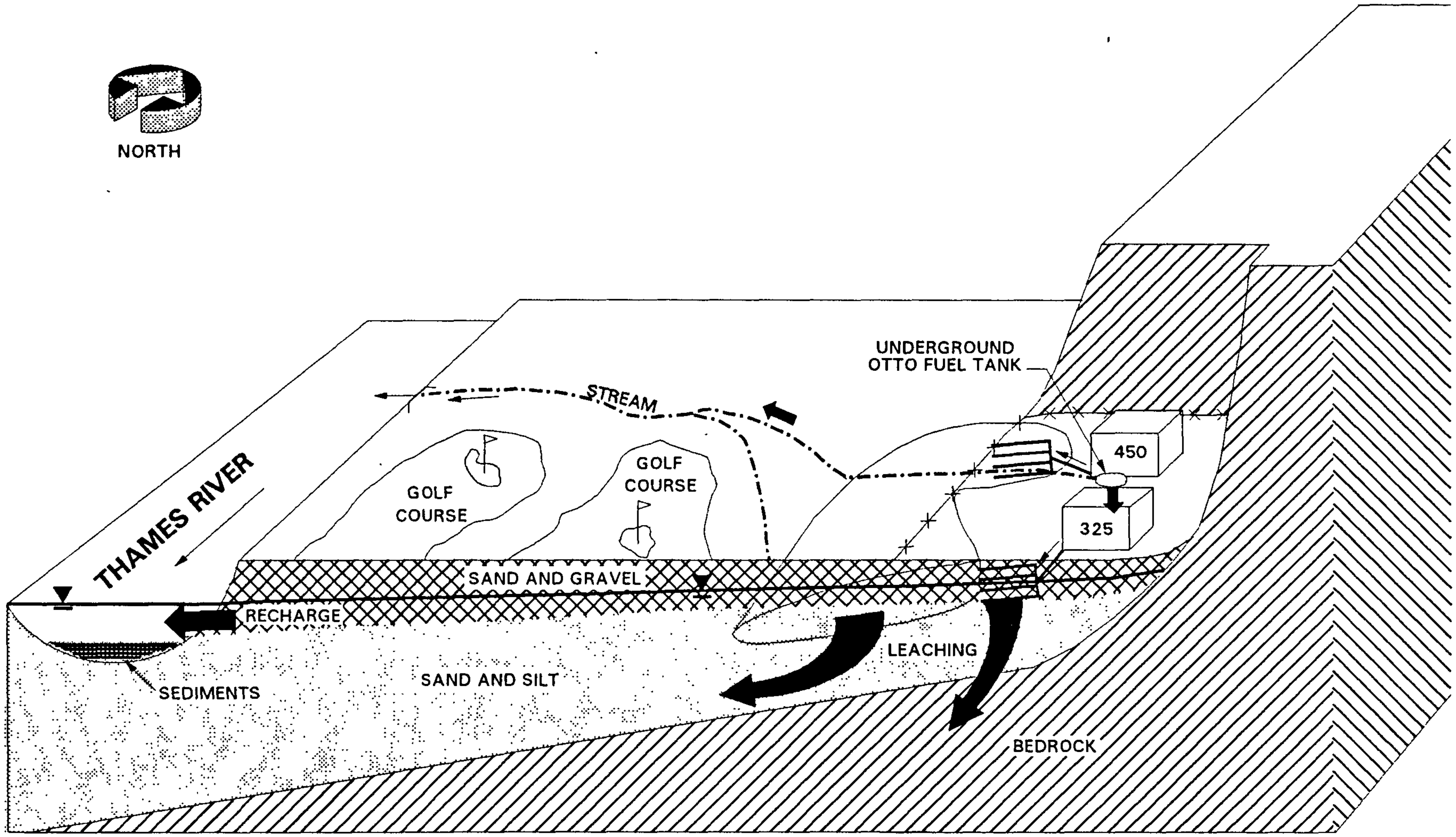
Ground Water and Soils: Contaminants in soil have the potential to leach to ground water at this site. Ground water flow is to the south-southwest. Ground water discharges either to the Area A Downstream and/or the Thames River. Constituents detected in ground water were VOCs and antimony; therefore, migration of the chemicals in ground water is the transport mechanism. The presence of antimony in ground water is consistent with its presence in soils. Mobility is dependant upon its chemical form and could be medium to high.

Surface Water and Sediments: Surface water generally flows to the south-southeast overland and is collected by storm sewers and drainage ditches which flow to the west, eventually discharging to the Area A Downstream and from there into the Thames River. Surface soils/sediments could be contaminated; therefore, this is considered to be a potential migration route.

3.2.3 Goss Cove Landfill

Figure 3-3 summarizes the conceptual site model for the Goss Cove Landfill. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment is presented below.

Hazardous substances detected in site soils and ground water include moderate to high levels of VOCs, SVOCs (predominantly PAHs), PCBs and pesticides. The following inorganics



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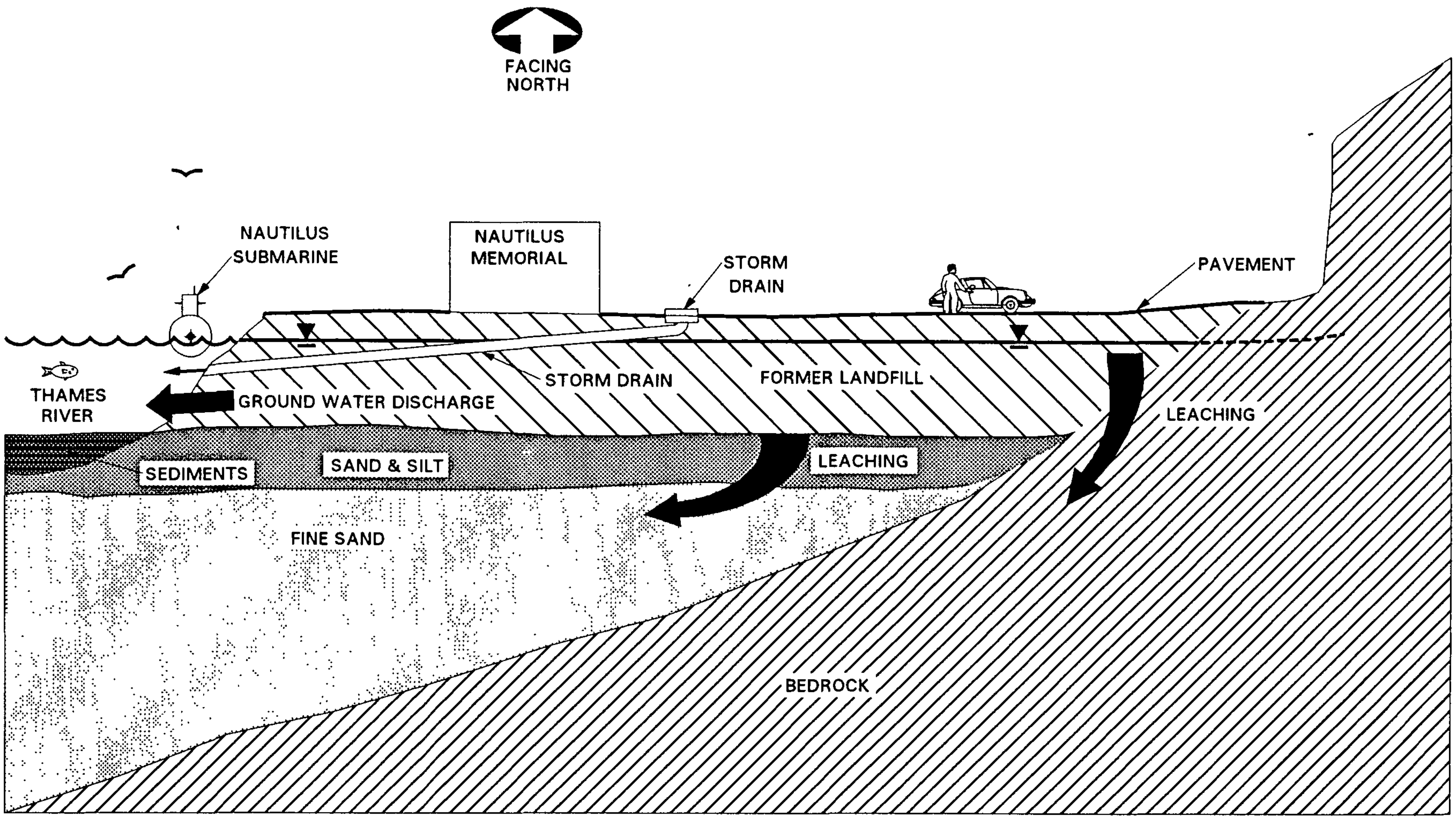
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-2
TORPEDO SHOPS
CONCEPTUAL SITE MODEL

ATLANTIC ENVIRONMENTAL SERVICES, INC.



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LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-3
GOSS COVE
CONCEPTUAL SITE MODEL

ATLANTIC ENVIRONMENTAL SERVICES, INC.

were detected above background levels in soils: arsenic, cadmium, chromium, lead and mercury.

Ground water contained moderate levels of VOCs, low levels of SVOCs, sodium above the CTDOHS notification levels, and iron and manganese above secondary MCLs. The apparent sources of contamination are the landfill materials disposed of at the site.

Air: The entire area has a vegetative or asphalt cover. Therefore, air transport of fugitive dust is not considered to be a significant pathway for contaminant migration. VOCs and low molecular weight SVOCs are present at significant concentrations and could potentially migrate to subsurface confined spaces such as the Nautilus Museum and the proposed trenches for installation of new storm sewers.

Ground Water and Soils: Contaminants in soil are located above and below the water table. As a result, contaminants will leach from soils to ground water and, to a limited degree, infiltrating precipitation. Ground water flow is to the northwest at this site with discharge to the adjacent Thames River. Ground water at Goss Cove flows at an estimated velocity of 1.7 feet per day. Pesticides and PCBs are not partitioning from soils to ground water at detectable concentrations due to their low solubility and partition coefficients. VOCs which have higher solubilities, and thus high mobility, are detected in ground water. SVOCs which have moderate to high soil concentrations were only detected at low levels in ground water, and have moderate to low migration rates. The metals present above background concentrations in soils were not detected in ground water above MCLs. This suggests that the metal compounds present are tightly adsorbed to soils and have a low migration potential. Transport via ground water to the Thames River is considered to be a potential contaminant migration route for VOCs and SVOCs.

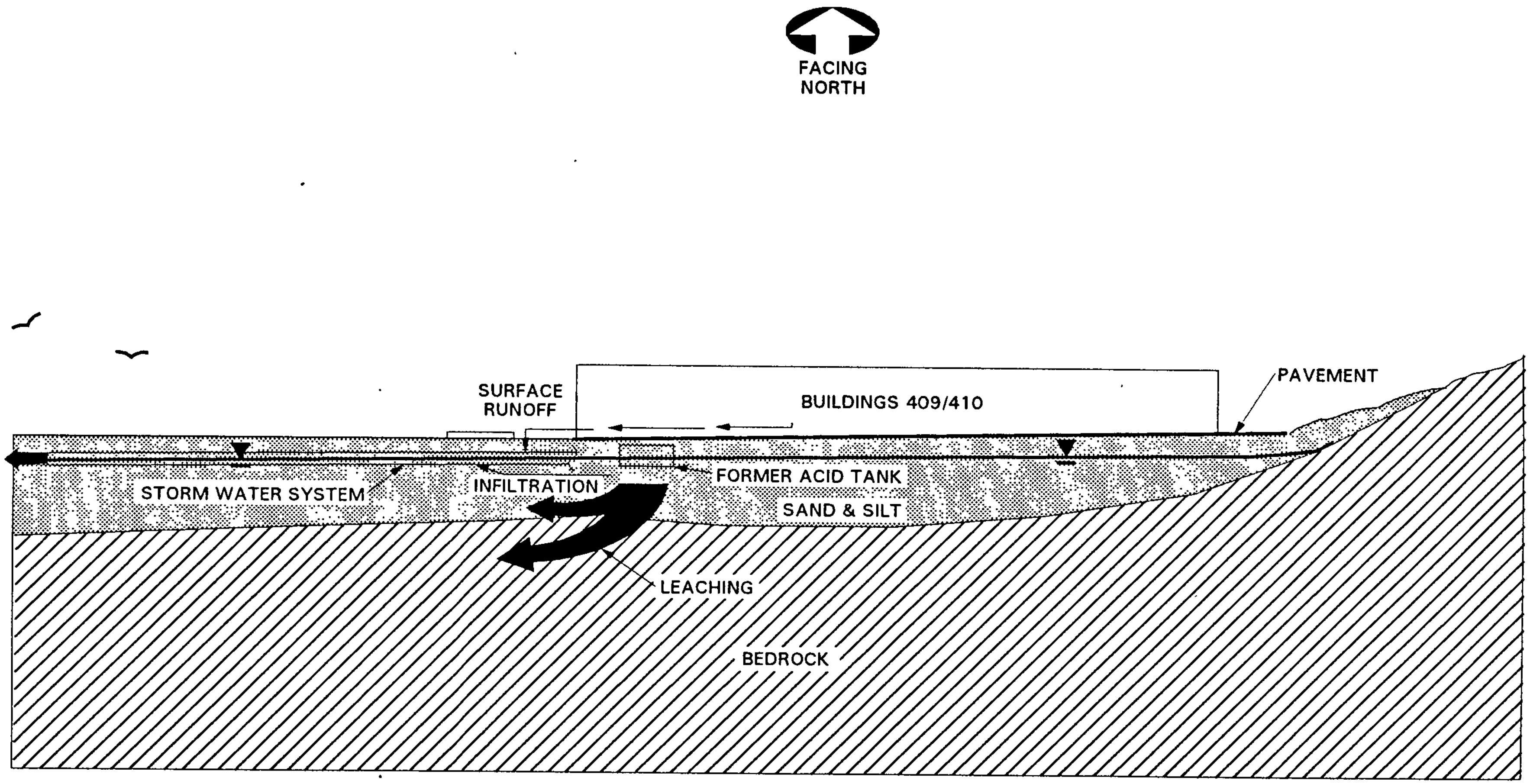
Surface Water and Sediments: Surface water at this site migrates primarily as overland flow to the west where it is collected by storm sewers and discharged to the Thames River. Most of the site is paved or covered with vegetated loam, which is believed to be uncontaminated. Therefore, migration of contaminants by surface water flow is not considered to be a potential route for chemical transport, except for transport of contaminants to the Thames River and Goss Cove from ground water discharging to the storm water culvert.

3.2.4 Spent Acid Storage and Disposal Area

Figure 3-4 summarizes the conceptual site model for the Spent Acid Storage and Disposal Area. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment are presented below.

Subsurface soils contain elevated levels of lead. Low levels of VOCs and PAHs were detected, but not in concentrations of concern. The apparent source of contamination at the site is the abandoned acid pit, which was used to contain spent battery acid in the past.

Air: The site is covered with pavement; therefore, transport of lead in fugitive dust will



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LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-4
SPENT ACID STORAGE AND DISPOSAL AREA
CONCEPTUAL SITE MODEL

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only be a significant migration route when this surface layer is disturbed during construction activities.

Ground Water and Soils: Lead is present in soils and has the potential to leach to ground water. The pavement will minimize but not eliminate infiltration, and some lead is probably present below the water table. Most lead compounds migrate slowly, adhere tightly to soils, and will not partition to ground water in significant concentration.

No ground water monitoring wells have been installed in this area. The ground water flow direction is inferred to be generally southwest.

Surface Water and Sediments: Surface water flow is generally to the west-southwest where it is collected by the storm sewer system and eventually discharged to the Thames River at Goss Cove. Since this site is covered with pavement, transport by surface water is not a significant contaminant migration route. Depending on the depth of the storm sewer system, some ground water infiltration to the storm sewer is possible. It would be expected that lead will not readily dissolve in surface water and would be transported primarily as suspended soil particles onto which it adsorbs.

3.3 Supplemental Step II Investigations

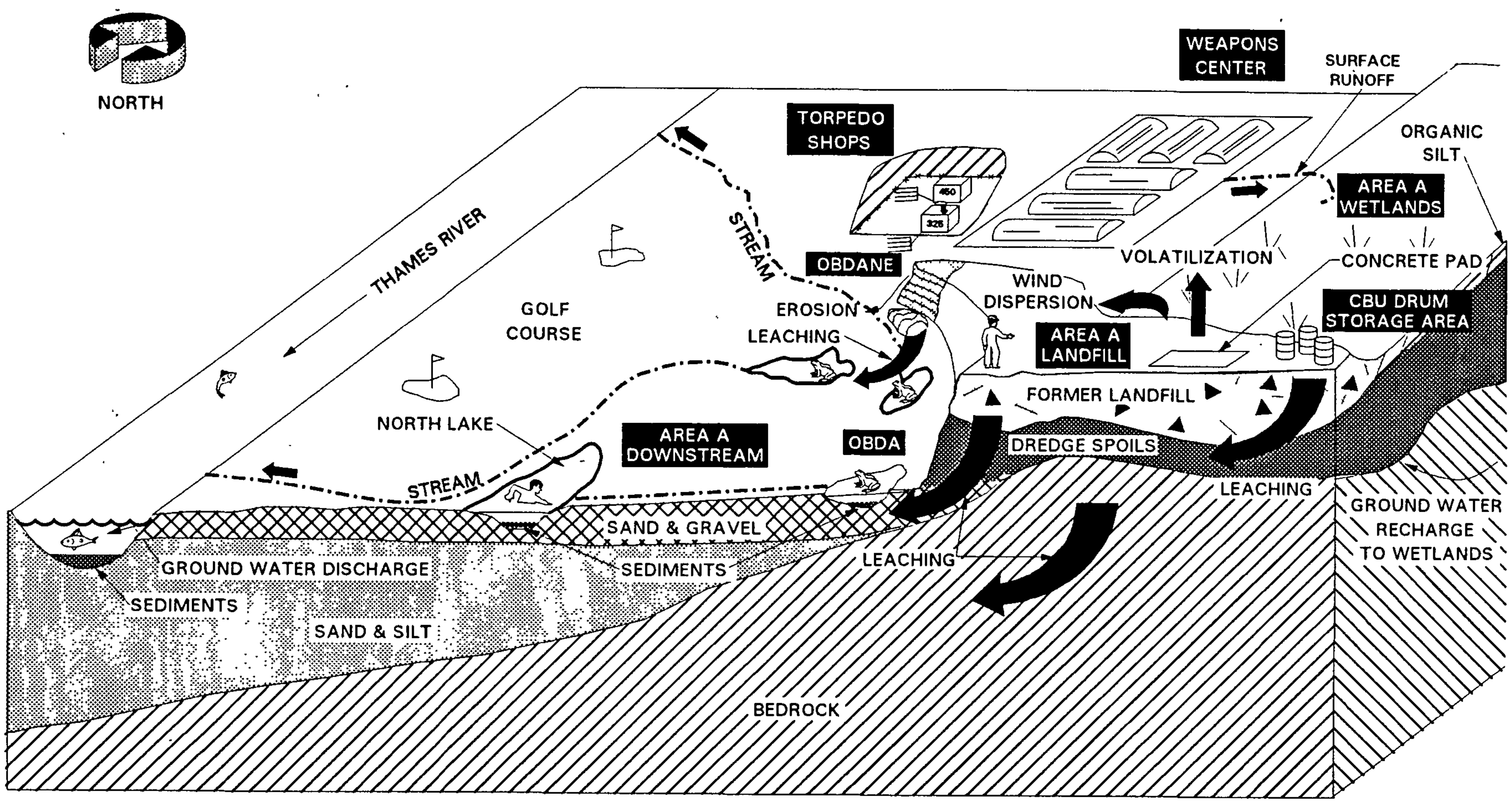
3.3.1 Area A

Figure 3-5 summarizes the conceptual site model for Area A. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment is presented below.

There are a number of documented releases in Area A soils and sediments. These include low levels of VOCs and SVOCs in the Landfill, Wetland and Downstream/OBDA areas. Some areas of the wetland contained moderate levels of VOCs and some of the sediments near OBDA contained moderate levels of SVOCs and VOCs. PCBs were detected at moderate levels in one surface soil sample at the landfill and at low levels in the wetland. DDTR was detected at low levels in the landfill and wetland and in high concentrations in the Downstream/OBDA area sediments. Several inorganics were detected above published background concentrations; however, the U.S. EPA has requested that site-specific background levels be developed for this project. A separate approved work plan is presently being implemented to define site-specific background levels of inorganics in soils. The specific metals are listed below by site.

Area A Landfill:	beryllium, cadmium, lead, mercury, copper, nickel, boron
Area A Wetland:	lead, mercury, cadmium, silver
Area A Downstream/OBDA:	beryllium, cadmium, lead, selenium, zinc, boron

The only inorganic detected which is not naturally occurring in soils is cyanide. Low levels of cyanide were detected in a drainage channel discharging from the Weapons Center.



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INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-5
AREA A
CONCEPTUAL SITE MODEL

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Area A ground water was found to contain low levels of VOCs, with one occurrence of PCBs in the landfill, and cadmium above MCLs. The following inorganics were also measured above ARAR or TBC values: iron, manganese, sodium and aluminum.

Surface water in the Area A Wetland and Downstream watercourses contained low levels of aromatic VOCs in one stream segment, one occurrence of DDTR, and the following metals above ARAR or TBC values: cadmium, lead, copper, iron and manganese. The likely sources of contaminants at the site are the dredge spoils that were deposited in the wetland area, the fill materials deposited at the landfill, and the pesticides within the wetland sediments.

__Air:__ Several portions of this area are uncovered and contain contaminants in surficial soils which tightly adsorb to soil particles (PCBs and DDTR). Fugitive dust containing adsorbed contaminants could be generated in this area and transported offsite. VOCs are present in low concentrations and will not have a measurable impact on ambient air quality; however, significant exposures may exist in subsurface confined spaces (e.g., utilities).

__Ground Water and Soils:__ Contaminants are present above and below the water table; therefore, contaminants may be leached from soils by both infiltrating precipitation and flowing ground water. In the overburden, the highest ground water elevation is in the central portion of the Area A Landfill. It appears that ground water in the central-eastern portion of Area A flows north toward the Area A Wetland, and ground water in the northwestern portion of the Area A Landfill flows northwest toward the Area A Downstream and eventually to the Thames River. The velocity of ground water flow through soils in the landfill and wetland portions of Area A was estimated to be 0.04 feet per day. The ground water flow velocity through the soils in Area A Downstream was calculated to be 0.13 feet per day. Ground water discharges to the wetlands, Area A Downstream surface waters and, ultimately, to the Thames River.

Ground water flow in the bedrock is generally to the west. Transmissivity values in the bedrock range from 4.7 to 250 ft^2/day, indicating a high variability of transmissive properties within the fractured bedrock.

VOCs detected in soils and sediments in low to moderate concentrations are highly mobile and were detected in low concentrations in ground water. The SVOCs, PCBs and pesticides detected in site soils have low mobilities. There was only one occurrence of PCBs in ground water. If this result is correct, the presence of PCBs in ground water suggests a concentrated source of PCBs in soil near the location where it was observed (2LMW18S). Metals are generally immobile and partition strongly to soils with some exceptions. Of the seven metals detected above background in soils, only cadmium was detected in ground water above MCLs. Cadmium is substantially more soluble in natural waters than many metals; therefore, its presence in ground water is not surprising. All other metals were apparently in relatively immobile forms. Other inorganics were detected in ground waters above ARAR or TBC values. These inorganics were not present above background in soils; however, their natural concentrations in soils are high. These include: iron, manganese and sodium. These inorganics are more soluble in reducing environments. It appears that the landfill and wetland have altered the natural environment to cause the leaching of these materials from soils into ground water at elevated levels.

Surface Water and Sediments: There are erodible surfaces that may contain adsorbed contaminants in Area A. Surface soils also contain chemicals that could dissolve in runoff. As a result, surface water is a potential contaminant migration pathway.

Surface water from this site originates from runoff within the northern Subase watershed area, and from ground water discharge to Area A Wetland and Downstream surface waters. The primary surface water discharge point from the Area A Wetland is through four 24-inch metal culverts through the dike. This discharge forms a small stream which flows west approximately 200 feet into a small pond. Wetland sediments accumulate upstream of the dike. Under normal flow conditions, this pond discharges to a small stream which flows north and then west toward Triton Avenue (past the OBDANE site). The stream continues flowing west under Triton Avenue and Shark Boulevard and eventually discharges to the Thames River at the DRMO outfall. This pond also has a discharge structure on the south side. During periods of high flow and high water at the pond, water also flows out through this structure to a stream which flows south from the OBDA site. A second pond to the south of the pond referenced above is formed by ground water inflow, and an outlet stream flows within a culvert to the west around North Lake.

Ground water also discharges from Area A to a small wetland at the base of the dike and the OBDA site. A stream flows from this wetland west toward North Lake, a recreational swimming area for Navy personnel. The stream enters a culvert which bypasses the pond and discharges below the outfall of the pond. This stream flows west under Shark Boulevard and through the golf course to the Thames River. There is a manhole adjacent to North Lake which previously connected to another pipe that was designed to discharge overflow water from North Lake. This pipe has been plugged to prevent any possible water discharge from the stream to North Lake.

A substantial amount of surface water flow at this site is due to ground water discharge. As a result, the discussion of inorganics in ground water also applies to inorganics in surface water. In addition, surface waters also contained lead and copper in concentrations above ARAR or TBC values. The surface water ARAR standards for these metals are more stringent than the MCLs for potable water. Lead and copper were present in ground water. When ground water in a reduced condition discharges to surface water, it becomes oxidized. This change in chemical environment can cause metal compounds to oxidize to a less soluble form. Iron is less soluble in the oxidized state. This phenomenon explains the orange precipitates forming at the base of OBDA.

The majority of VOCs discharged to surface water will volatilize to air and a smaller percentage will adsorb to sediments. VOCs were only detected at low concentrations in one small segment of one of the small streams downstream of Area A.

DDTR was measured in high concentrations in sediments and only once in measurable concentrations in surface water. This is expected based upon DDTR's chemical properties. DDTR is highly persistent and strongly adsorbs to soils and organic matter. Sorption appears to be the dominant environmental process affecting the fate of DDTR. Water solubilities indicate that transport in ground water or surface water of dissolved DDTR is not likely.

Transport of DDTR on particles to which it is strongly adsorbed is a significant migration route in Area A Downstream watercourses. The sediment sample results indicate that DDTR contaminated sediments have migrated to the Thames River. Some volatilization of DDTR could take place in surface soils exposed to the atmosphere. DDTR is also taken up by biota and bioaccumulated.

The behavior of cyanide in the environment is strongly dependent upon its chemical form. Under CLP, cyanide values given are for total cyanide only. There is not enough data regarding the occurrence or form of cyanide to define the most significant migration pathways.

3.3.2 DRMO

Figure 3-6 summarizes the conceptual site model for the DRMO. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment is presented below.

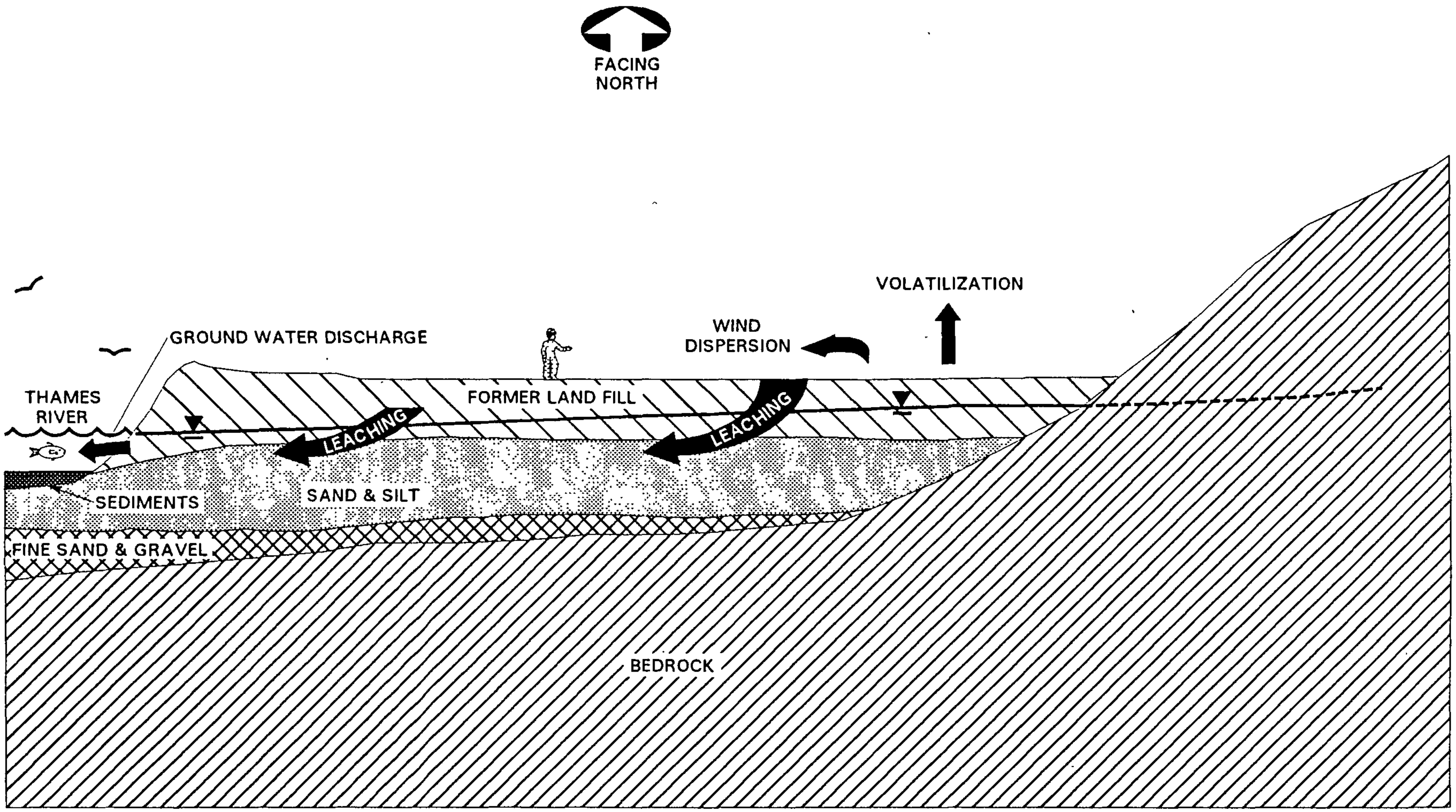
Documented soil contaminants at this site include: low concentrations of VOCs with one isolated hot spot; moderate levels of SVOCs comprised predominantly of PAHs; PCBs in low to moderate concentrations; moderate to high concentrations of DDTR at one sample point; and metal concentrations above background. The most significant metals (relative to health or ecological risk) detected above background levels include cadmium, lead, and mercury. In ground water, VOCs were present in low levels, and the following inorganics were present above TBC or ARAR values: boron, sodium, iron, manganese and selenium. The apparent source of contamination at the site is the fill material deposited at the site and spillage from site activities.

Air: The northern portion of this site is not paved or vegetated; therefore, fugitive dusts are easily generated and constitute a potential contaminant migration route.

VOCs in subsurface soil and ground water were present at low to moderate levels. There are no subsurface confined spaces or trenches in existence or proposed in this area; therefore, migration to such spaces is not a potential pathway. VOC levels near the office building were low and therefore are not considered to be an indoor air quality concern. Concentrations of volatile compounds are too low to be of concern in ambient air.

Ground Water and Soils: Contaminants are present in subsurface soils above and below the water table and can migrate with infiltrating precipitation and ground water. Ground water in this area flows to the west at an estimated velocity of 0.7 feet per day and discharges to the Thames River.

VOCs are highly mobile and their concentrations in ground water are consistent with those in soils. SVOCs, comprised predominantly of PAHs, pesticides and PCBs, all appear to be tightly bound to soils and are not partitioning to ground water in detectable concentrations. All of these compounds have low mobilities. The inorganics detected in ground water above TBC or ARAR values are either constituents of salt water (boron, sodium) or have leached from the soils due to reducing conditions in the fill (iron, manganese). The only exception is



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GROTON, CT

LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-6
DRMO
CONCEPTUAL SITE MODEL

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selenium. The reasons for its elevated concentration are not apparent. Ground water transport of VOCs and certain metals to the Thames River is a potential migration route.

Surface Water and Sediments: Surface water at DRMO flows as overland flow to the west and discharges to the Thames River. The soil surface here is erodible and the compounds present strongly partition to soil particles and have low solubilities. Therefore, the primary migration route by surface water is transport of contaminated suspended particles in runoff to the Thames River. PCBs were detected in Thames River sediment adjacent to the DRMO site.

3.3.3 Lower Subase

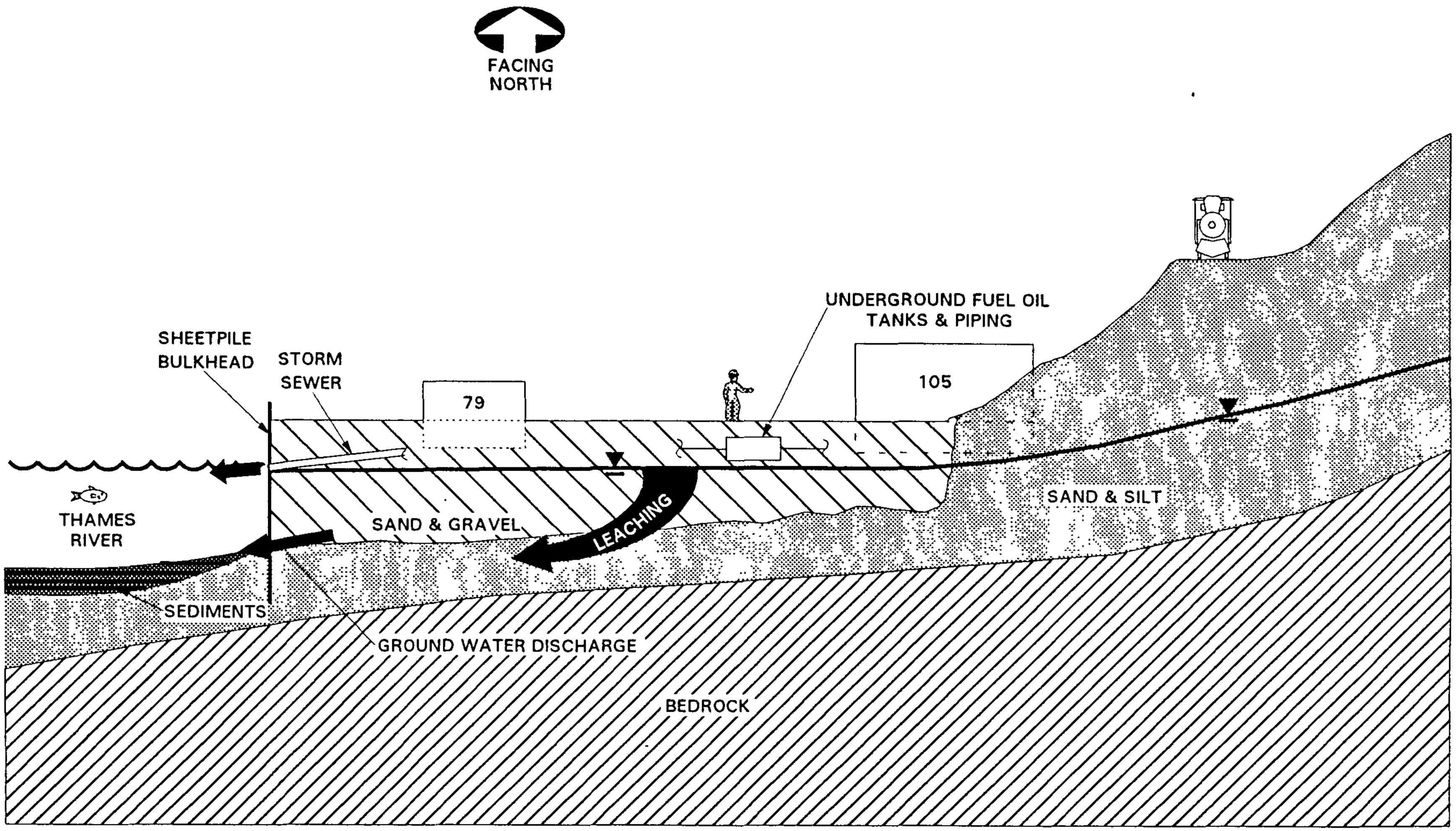
Figure 3-7 summarizes the conceptual site model for the Lower Subase. A summary of contaminants detected to date and an evaluation of potential migration pathways of chemicals in the environment is presented below.

Documented releases to soils include moderate to high concentrations of petroleum hydrocarbons, moderate levels of lead, and low concentrations of aromatic and halogenated VOCs. Ground waters contained low levels of VOCs, traces of petroleum hydrocarbons, and metals above ARAR or TBC values. The apparent sources of contamination at the site are underground storage tanks used to store acid and fuel oil, a former maintenance pit in Building 79 and any associated underground piping.

Air: This area is completely covered with vegetation, asphalt, concrete or buildings. Therefore, fugitive dusts are not considered to be a potential migration pathway under present conditions. VOCs are only present in trace to low concentrations in subsurface soils and ground water; however, there are extensive subsurface confined spaces in this area such as utility trenches that offer a potential contaminant migration pathway.

Ground Water and Soils: Contaminants in this area are present in soils above and below the water table. Contaminants can migrate from infiltrating precipitation and by leaching directly via ground water. Ground water in this area flows to the west at an estimated velocity of 1.3 feet per day, except for those areas near the Thames River which are influenced by tidal flow. In addition, the Lower Subase contains extensive underground utilities and structures which could offer preferential flow paths for contaminants. Regardless of tides and utilities, the ultimate discharge point of ground water at the Lower Subase is the Thames River.

Oils contain a complex mixture of hydrocarbons which include aromatic hydrocarbons and PAHs. The aromatic hydrocarbons have a medium to high mobility rate, whereas the PAHs have a lower mobility. Weathered oils typically contain lower VOCs and higher PAHs than fresh oils. Lead compounds normally have a low mobility partition to soils and are not found in high concentrations in ground water. Chlorinated VOCs detected at the Lower Subase are highly mobile. Constituents detected in ground water above potential ARAR levels include cadmium, lead, selenium, benzene, 1,1-dichloroethene, and vinyl chloride.



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INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

- Potential Transport Mechanism
- Ground Water

FIGURE 3-7
LOWER SUBASE
CONCEPTUAL SITE MODEL

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Surface Water and Sediments: Surface waters are collected by an extensive storm sewer system and discharge to the Thames River. This site is completely covered by buildings and pavement; therefore, runoff is not believed to contact contaminants in soils. However, ground water infiltration to the storm sewer system is possible.

4.0 HUMAN HEALTH RISK ASSESSMENT

4.1 Introduction

The scope of work outlined below pertains to the Step II and Supplemental Step II sites included in the Phase II Remedial Investigation (Phase II RI) at the Naval Submarine Base - New London in Groton, Connecticut. It provides detailed information on the potential human exposures that will be evaluated in the quantitative risk characterization. Specific details on exposure pathways and methodology are presented for review prior to commencing work on the Phase II RI.

The risk assessment at CBU Drum Storage Area and OBDANE will be performed on a qualitative basis. The qualitative risk assessment is intended to provide an initial indication concerning the need for additional investigation or no action. Factors considered in the qualitative assessment will include: site history, site use and potential exposure groups, and contaminant concentrations. The chemical data will be reviewed for frequency of detection and level detected. The assessment will be based on a comparison of contaminant concentrations to health based ARARs for ground water and soil, site-specific background concentrations for inorganics in soil, exposure calculations based on maximum and mean contaminant concentrations in soil, and professional judgement as to potential risk a contaminant may pose at certain concentrations in a particular medium. For example, if a site has contaminant concentrations consistently above ARARs or site-specific background concentrations, the risk assessment will indicate a need for additional investigation or a quantitative risk assessment.

The risk characterization for the Step II Sites will evaluate the risks to human health associated with exposure to the compounds detected at the site. This Work Plan describes the steps that will be conducted to complete the risk assessment for the identified sites. The assessment will characterize risks associated with current and reasonably foreseeable land use caused by contact with contaminants at, or released from, the sites in the absence of any actions to control or mitigate these releases.

The baseline risk assessment will have four steps:

- data evaluation and hazard identification
- exposure assessment
- toxicity assessment
- risk characterization

The explicit and largely quantitative process will take into account the nature of the hazard posed by onsite contaminants, the potential effects associated with particular exposure levels, and the magnitude and durations of potential exposures.

The risk assessment will provide estimates of potential risks to human health. Risks will be estimated for representative groups that might encounter contaminants on or from the site. Conservative (i.e., protective of human health) assumptions will be used to estimate risks.

The human health risk assessment will be conducted in accordance with the guidance provided in: *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (U.S. EPA 1989a); *Guidelines for Exposure Assessment* (U.S. EPA 1992d); and U.S. EPA Region I's *Supplemental Risk Assessment Guidance for the Superfund Program* (U.S. EPA 1989b). Additional guidance is found in the U.S. EPA update memorandum entitled *Supplemental Guidance: Standard Default Exposure Factors* (U.S. EPA 1991); *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA 1992a); *Risk Assessment for Polyaromatic Hydrocarbons* (U.S. EPA 1992c); and the *Exposure Factors Handbook* (U.S. EPA 1989c).

A Phase I Remedial Investigation of the Naval Submarine Base was conducted by Atlantic Environmental Services, Inc. in August 1992. A quantitative human health risk assessment was included in the report and submitted to U.S. EPA Region I for comment. This risk assessment will incorporate the comments and site-specific guidance for all of the sites recommended by U.S. EPA.

4.1.2 Site Description

Due to the complexity and magnitude of NSB-NLON, the site has been divided into subsites (referred to as "sites"). The following four Step II sites will be examined in the quantitative human health risk assessment:

- Rubble Fill at Bunker A-86
- Torpedo Shops
- Goss Cove Landfill
- Spent Acid Storage and Disposal Area

Additional sampling data will be collected at three Step II sites in order to define better the extent of contamination in those areas. These sites are:

- Area A
- DRMO
- Lower Subase

Although a quantitative risk assessment has been completed for these sites, the new sampling data as well as the comments submitted by U.S. EPA Region I will be incorporated into the revised risk assessment for these sites.

A detailed description of each of these sites is presented in Section 2.0 of this Work Plan. A brief description of the site is presented here.

- **Rubble Fill at Bunker A-86:** This site is only used for storage of materials and was used for rubble fill disposal. The site area is located adjacent to Bunker A-86 with limited access.

- **Torpedo Shops:** This site is highly secured and fenced. There are underground storage tanks and utility lines beneath this site. Two buildings onsite are used to overhaul torpedoes.

- **Goss Cove Landfill:** This is the site of the Nautilus Museum and a paved parking lot. The site is open to the public. A utility tunnel exists from the building to the pier. Standing water has been observed inside the tunnel. Various underground utilities are located at the site. An underground fuel oil storage tank is located near the museum entrance. Goss Cove is accessed as a Thames River coastal viewing area.

- **Spent Acid Storage and Disposal Area**: This small area is beneath a paved parking lot. The buried tank was formerly used for the storage of battery acid. Water mains and sanitary and storm sewers are present on the site.

- **Area A:** This large, unfenced, predominantly unpaved site is a storage area and long-term parking lot for Naval personnel, and is accessed by a dirt road. There are utility lines and storm sewers at this site. Other areas of this site include a large wetland area, downstream watercourses, and the Weapons Storage center.

- **DRMO:** This is a restricted area with controlled security gates. There are fences to deter trespassers from entering. The DRMO buildings are constructed on concrete slabs with metal roofs. There are utility lines beneath the area. This area is used for storage and sale of excess government supplies and equipment.

- **Lower Subase:** This is a high security, restricted area with controlled gates. The site is bound by the Thames River. There are utility trenches and fuel lines at this site. There are multiple buildings onsite serving various functions.

4.2 Data Evaluation and Hazard Identification

The objective of the Data Evaluation and Hazard Identification phase of the assessment is to provide an initial evaluation of data, to provide a preliminary assessment of potential hazards, and to select compounds of potential concern for the quantitative risk assessment. The compounds detected at Area A, DRMO and Lower Subase sites were evaluated with regard to frequency of detection, concentration above background concentrations, and toxicity. The compounds of potential concern that were selected for these Step II sites were carried through the previous risk characterization, and are listed in Table 4-1. Sampling is required for supplemental investigations at these Step II sites. The outcome of the sampling will dictate the final list of compounds of concern. Prior to implementation of this work plan, sampling and analysis to define inorganic concentrations in soils will be conducted. Background sampling is conducted to distinguish site-related contamination from naturally occurring or other non-site-related levels of compounds. In addition, compounds of concern will be selected for the Rubble Fill at Bunker A-86, Torpedo Shops, Goss Cove Landfill, and Spent Acid Storage Area sites based upon the same criteria. Additional sampling will also be completed for these sites.

TABLE 4-1 CONTAMINANTS OF CONCERN BY MEDIUM				
	Soil	**Sediment**	**Surface Water**	**Ground Water**
		Volatile Organic Compounds		
Nonchlorinated Aromatics				
Benzene	●			●
Ethylbenzene	●	●	●	●
Toluene	●			●
Xylene (total)	●	●	●	●
Chlorinated Compounds				
Chloromethane			●	●
1,1-Dichloroethane	●			●
1,2-Dichloroethane	●			
1,1-Dichloroethene	●			●
1,2-Dichloroethene (total)	●			●
Methylene Chloride	●	●		
Tetrachloroethane	●			
Tetrachloroethene	●	●	●	
Trichloroethene	●	●		●
1,1,1-Trichloroethane				●
1,1,2-Trichloroethane	●			
Vinyl Chloride	●			●
Other VOCs				
Acetone	●	●		●
2-Butanone	●	●		
4-Methyl-2-Pentanone	●			●
Carbon Disulfide	●	●	●	●
		Semivolatile Compounds		
Noncarcinogenic PAHs				
Acenaphthene	●	●		●
Acenaphthylene	●	●		
Anthracene	●	●		
Fluoranthene	●	●		●
Fluorene	●	●		●
2-Methylnaphthalene	●			●
Naphthalene	●	●		●
Phenanthrene	●	●		●
Pyrene				

TABLE 4-1 (continued) CONTAMINANTS OF CONCERN BY MEDIUM				
	Soil	Sediment	Surface Water	Ground Water
Carcinogenic PAHs				
Benzo(a)Anthracene	●	●		
Benzo(a)Pyrene	●	●		
Benzo(b)Fluoranthene	●	●		
Benzo(g,h,i)Perylene	●	●		
Benzo(k)Fluoranthene	●	●		
Chrysene	●	●		
Dibenzo(a,h)Anthracene	●			
Indeno(1,2,3-cd)Pyrene	●	●		
Other Semivolatile Compounds				
bis(2-Ethylhexyl)Phthalate	●		●	●
Di-n-Butylphthalate	●	●		
2,4-Dimethylphenol				●
4,6-Dinitro-2-methylphenol		●		
2-Methylphenol				●
4-Methylphenol	●	●		●
Phenol				●
Benzoic Acid	●	●		●
4-Chloroaniline	●	●		
Dibenzofuran	●	●		●
2-Nitroaniline		●		
Ni-Nitrosodiphenylamine (1)	●			
Pesticides				
4,4'-DDE	●	●	●	
4,4'-DDD	●	●	●	
4,4'-DDT	●	●		
BHC	●			
Endrin	●			
Endrin Ketone	●			
Methoxychlor	●			
PCBs				
Aroclor 1260	●	●		
Aroclor 1254	●			●

TABLE 4-1 (continued) CONTAMINANTS OF CONCERN BY MEDIUM				
	Soil	**Sediment**	**Surface Water**	**Ground Water**
Inorganics				
Metals				
Aluminum	●	●	●	●
Antimony	●			●
Arsenic	●	●		●
Beryllium	●	●		
Boron	●	●	●	●
Cadmium	●	●	●	●
Copper	●	●	●	●
Iron	●	●	●	●
Lead	●	●	●	●
Manganese	●	●	●	●
Mercury	●	●	●	●
Nickel	●	●	●	●
Selenium	●	●	●	●
Zinc	●	●	●	●

4.2.1 Evaluation of the Quality of Available Data

The selection of data from each medium of concern will be based on an evaluation of appropriately qualified data with respect to appropriateness of method, standard quantitation limits, and laboratory and field blank concentrations (U.S. EPA 1992).

For CLP evaluated data, all unqualified data and data with "J" qualifiers (indicating the presence of the compound at an estimated concentration) or "U" qualifiers (indicating the compound was not detected) will be considered adequate for risk assessment. The "U" qualifier indicates that the analyte was not detected in the sample and is an acceptable analytical result. If use of this sample is indicated by the exposure assumptions, and there is reason to believe that the analyte is present at a level below the SQL, then the sample will be assigned a numerical value of one half the SQL. Non-detects with "unusually high SQLs" will generally be excluded from use in the quantitative risk assessment as described in RAGS, Section 5.3.2. All data with "R" qualifiers (indicating uncertain identity and concentration) will be rejected. Field and laboratory control samples will be excluded. The higher of the two measured values from duplicate samples will be included in the risk assessment.

4.2.2 Comparison of Site-Related Contamination with Background

A comparison of sample concentrations with background concentrations will be used for some of the metals (e.g., antimony, lead) found in the soils at the sites. Background samples will be taken from "clean" media at the Naval Base. A separate Work Plan has been prepared for the background soil sampling for inorganics.

4.2.3 Selection of Compounds of Potential Concern

The compounds of potential concern are those judged to be important site-related contaminants with regard to potential human health risks. Selection of compounds of potential concern was made based on a review of available data and a consideration of the following criteria:

- Only compounds for which positive data (i.e., analytical results for which measurable concentrations are reported) were available in at least one sample from each medium were considered as compounds of concern for the site. If there were no positive data, and information existed to indicate that the compound was present (e.g., fate and transport characteristics of the compound, or detection of the compound in other media), then that compound was included.

- The quantitation limit of a compound must have been less than corresponding standards, criteria, or concentrations derived from toxicity reference values.

- The presence of an inorganic compound was at concentrations above its natural range of elemental abundance (Shacklette and Boerngen 1984).

- The spatial extent of contamination was considered by the evaluation of the selection of sampling locations, presence of potential hot spots and a sufficient number of samples collected over the time frame of the investigation.

The compounds of concern at NSB-NLON identified in the previous Step II investigation are listed in Table 4-1. There may be additional compounds specific to a particular site based on additional sampling. If not, then the original list of compounds of concern will be used in the exposure analyses.

4.3 Exposure Assessment

The objective of the Exposure Assessment section is to estimate the type and magnitude of exposures to the compounds of potential concern that are present at or are migrating from the site. Exposure is the contact of an organism with a chemical or physical agent. The magnitude of exposure is determined by measuring or estimating the amount of the chemical or agent available at the exchange boundaries (i.e, the lungs, gut, or skin) during a specified time period. Exposure assessment is the determination or estimation of the magnitude, frequency, duration and route of exposures.

4.3.1 Identification of Potentially Exposed Populations: Current Land Use

Current receptors at the sites include: visitors, residents of NSB-NLON and Groton/Ledyard, military and civil personnel working at the sites, families and children of military personnel living on the base, construction workers, and utility workers. These individuals could be exposed to site compounds via contact with air, soils, dusts, sediments, surface water, or ground water, depending upon the types of activities in which they are engaged and the location. A summary of the potential receptors and pathways for current exposure at the sites is shown in Table 4-2. This list will be modified based upon additional sampling data. The assessment of the ground water inhalation and dermal contact pathways will be addressed qualitatively.

4.3.2 Identification of Potentially Exposed Populations: Future Land Use

The identification of exposed populations and exposure routes under current and future land conditions will be explained and justified in the Phase II Remedial Investigation risk assessment report. Future receptors at the sites include: workers involved in excavation and construction activities at the Torpedo Shops and the Spent Acid Storage and Disposal Area, and workers involved in excavation activities for placement/repair of utility lines at the Rubble Fill at Bunker A-86 and Goss Cove Landfill. The individuals engaged in these activities could be exposed to site compounds via release of volatile organic compounds from soils and ground water during excavation, and contact with soils during excavation and construction.

Based on the state classification of the ground water on the base, and discussion with personnel at U.S. EPA Region I, there exists the potential that local ground water in Area A could be used as a source of drinking water for onsite residents. Thus, residents could be exposed to site compounds in the ground water under this scenario. A summary of the potential receptors and pathways for future exposure at the sites is also shown in Table 4-2.

TABLE 4-2
EXPOSURE SUMMARY FOR POTENTIAL HUMAN RECEPTORS

POTENTIAL RECEPTOR	EXPOSURE POINTS	ACTIVITY	EXPOSURE MEDIUM	EXPOSURE ROUTE	AGE GROUP	FREQUENCY* EVENT/TIME	DURATION* TIME/EVENT	DURATION*
CURRENT LAND USE								
RUBBLE FILL AT A-86								
Site Visitor	fugitive dust	trespassing on road	soil	ingestion, dermal, inhalation	Child,	20 days/year		7 years
	surface soil				6-12 yrs old			
TORPEDO SHOPS								
Utility Worker	surface soil	repair of utility lines	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	subsurface soil		ground water**					
	fugitive dust							
	ground water							
Weapons Center Personnel	fugitive dust	torpedo technicians	soil	dermal, inhalation	Adult	250 days/ year		30 years
GOSS COVE LANDFILL								
Workers/Visitors	indoor air	inside museum	air	inhalation	Adult	250 days/year		30 years
Military personnel	surface soil	surveillance of	soil	ingestion, dermal, inhalation	Adult	250 days/year		3 years
	fugitive dust	grounds						
Visitor	surface soil	playing in or around	soil	ingestion, dermal, inhalation	Child,	55 days/year		7 years
	fugitive dust	Goss Cove	sediments		6-12 yrs old			
	sediments		surface water					
	surface water							
Utility Worker	surface soil	repair of utility lines	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	subsurface soil		ground water**					
	fugitive dust							
	ground water							
SPENT ACID STORAGE								
Utility Worker	surface soil	repair of utility lines	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	subsurface soil							
	fugitive dust							

TABLE 4-2
EXPOSURE SUMMARY FOR POTENTIAL HUMAN RECEPTORS

POTENTIAL RECEPTOR	EXPOSURE POINTS	ACTIVITY	EXPOSURE MEDIUM	EXPOSURE ROUTE	AGE GROUP	FREQUENCY* EVENT/TIME	DURATION* TIME/EVENT	DURATION*
AREA A								
Utility Worker	surface soil	repair of storm sewers	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	subsurface soil		ground water**					
	fugitive dust							
	ground water							
Weapons Center Personnel	fugitive dust	working	soil	dermal, inhalation	Adult	250 days/year		30 years
Military Personnel	surface soil	moving palettes	soil	ingestion, dermal, inhalation	Adult	250 days/year		3 years
	fugitive dust		air					
	outdoor air							
Military Personnel	fugitive dust	recreational activities	soil	dermal, inhalation	Adult	120 days/year		7 years
Groton/Ledyard Residents	fugitive dust	living in area	soil	dermal, inhalation	Adult	350 days/year		30 years
Site Visitor	fugitive dust	attending car auction	soil	ingestion, dermal, inhalation	Adult	24 days/year		30 years
	surface soil							
Site Visitor	surface soil	subase children in woods	soil	ingestion, dermal, inhalation	Child,	56 days/year		7 years
	fugitive dust				6-12 yrs old			
Site Visitor	streambeds	subase children	sediments	ingestion, dermal	Child,	28 days/year		7 years
	wetland	exploring woods	water		6-12 yrs old			
Site Visitor	lake	subase children	water	ingestion, dermal	Child,	55 days/year	4 hours/day	7 years
		swimming	sediments		6-12 yrs old			
Utility Worker	surface soil	utility repair in	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	subsurface soil	downstream watercourse	ground water**					
	fugitive dust							
	ground water							

TABLE 4-2
EXPOSURE SUMMARY FOR POTENTIAL HUMAN RECEPTORS

POTENTIAL RECEPTOR	EXPOSURE POINTS	ACTIVITY	EXPOSURE MEDIUM	EXPOSURE ROUTE	AGE GROUP	FREQUENCY* EVENT/TIME	DURATION* TIME/EVENT	DURATION*
DRMO								
Site Visitor	fugitive dust	attending car auction	soil	ingestion, dermal, inhalation	Adult	24 days/year		30 years
	surface soil							
Site Visitor	fugitive dust	attending weekly	soil	ingestion, dermal, inhalation	Adult	26 days/year		30 years
	surface soil	public sales						
DRMO Personnel	surface soil	sorting scrap metal	soil	ingestion, dermal, inhalation	Adult	180 days/year		30 years
	fugitive dust		air					
	outdoor air							
Utility Worker	surface soil	utility repair	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	subsurface soil		ground water**					
	fugitive dust							
	ground water							
Ledyard Residents	fugitive dust	living	soil	dermal, inhalation	Adult	350 days/year		30 years
Subase Residents	fugitive dust	living near DRMO	soil	ingestion, dermal, inhalation	Child	350 days/year		7 years
	oudoor air	and Area A landfill	air					
LOWER SUBASE								
Utility Worker	surface soil	utility repair	soil	ingestion, dermal, inhalation	Adult	3.5 days/year		30 years
	subsurface soil	lower subase vaults	ground water**					
	fugitive dust							
	ground water							
Utility Worker	surface soil	utility repair	soil	ingestion, dermal, inhalation	Adult	3.5 days/year		30 years
	subsurface soil		ground water**					
	fugitive dust							
	ground water							
THAMES RIVER								
Area Residents	Thames River	ingestion of shellfish	shellfish	ingestion	Adult	24 days/year***		30 years
		caught off-site						

TABLE 4-2
EXPOSURE SUMMARY FOR POTENTIAL HUMAN RECEPTORS

POTENTIAL RECEPTOR	EXPOSURE POINTS	ACTIVITY	EXPOSURE MEDIUM	EXPOSURE ROUTE	AGE GROUP	FREQUENCY* EVENT/TIME	DURATION* TIME/EVENT	DURATION*
FUTURE LAND USE								
RUBBLE FILL AT A-86								
Utility Workers	surface soil	excavation for utility	soil	ingestion, dermal, inhalation	Adult	120 days/year		0.5 years
	fugitive dust	lines						
	subsurface soil							
	ground water							
TORPEDO SHOPS								
Civilian Workers	surface soil	construction	soil	ingestion, dermal, inhalation	Adult	80 days/year		1.5 years
	fugitive dust							
	subsurface soil							
GOSS COVE LANDFILL								
Utility Workers	surface soil	excavation for utility	soil	ingestion, dermal, inhalation	Adult	120 days/year		0.5 years
	fugitive dust	lines						
	subsurface soil							
	ground water							
SPENT ACID STORAGE								
Civilian Workers	surface soil	construction	soil	ingestion, dermal, inhalation	Adult	80 days/year		1.5 years
	fugitive dust							
	subsurface soil							
AREA A/OBDA								
Residents	water supply	drinking water	ground water**	ingestion, dermal, inhalation	Child	350 days/year		7 years
Residents	water supply	drinking water	ground water**	ingestion, dermal, inhalation	Adult	350 days/year		30 years
Workers	surface soil	drilling drinking water	soil	ingestion, dermal, inhalation	Adult	1 day/year		30 years
	fugitive dust	well	ground water**					
	subsurface soil							
	ground water							

TABLE 4-2
EXPOSURE SUMMARY FOR POTENTIAL HUMAN RECEPTORS

POTENTIAL RECEPTOR	EXPOSURE POINTS	ACTIVITY	EXPOSURE MEDIUM	EXPOSURE ROUTE	AGE GROUP	FREQUENCY* EVENT/TIME	DURATION* TIME/EVENT	DURATION*
DRMO								
Workers	surface soil	construction	soil	ingestion, dermal, inhalation	Adult	80 days/year		1.5 years
	fugitive dust		ground water**					
	subsurface soil							
	ground water							
LOWER SUBASE								
Utility Worker	surface soil	utility repair	soil	ingestion, dermal, inhalation	Adult	3.5 days/year		30 years
	subsurface soil		ground water**					
	fugitive dust							
	ground water							

* Exposure duration and frequencies were based on discussion with site personnel. If this information was unavailable, standard EPA default assumptions were used.

** Inhalation and dermal exposures to ground water will be addressed qualitatively.

*** Based upon a six month exposure duration/year due to weather considerations. The EPA default value is 48 days/year.

4.3.3 Exposure Point Concentrations

The exposure point concentrations (EPCs) represent the concentration of compounds of concern that is contacted over the exposure period. An arithmetic mean of the data will be used for estimating exposures since exposure is based on random visits and events which are then averaged. Average and maximum exposure point concentrations will be calculated to represent average-case and worst-case exposures.

For each group of data, samples with results below the analytical detection limit ("non-detects") will be assigned a value equal to one-half the associated sample quantitation limit prior to calculation of the exposure point concentrations. Individual non-detects with unusually high sample quantitation limits (SQLs) (due to unavoidable matrix interferences) will be excluded from the calculation if one-half the given SQL exceeds the maximum concentration detected in that data set.

Fugitive dust levels to which construction workers, residents, or Subase workers may be exposed will be estimated by multiplying an estimated PM10 concentration by the mean of the soil exposure point concentration. The PM10 designation is defined as the airborne particulate matter that is less than 10 um in diameter. A PM10 value of 0.09 mg/m^3 for the soil excavation activities will be used because it is a conservative estimate for a site with limited excavation (GRI 1987). This value is close to the maximum value measured during test pit excavations at the site and is higher than the average level measured at the site. Thus, it appears that the value is both representative and conservative.

To assess fugitive dust exposures to site workers and trespassers under non-excavation conditions, a representative particulate concentration (PM10) will be chosen from data presented in a recent U.S. EPA National Air Quality and Emissions Trends Report (U.S. EPA 1989d). By using a measured PM10 value from a nearby city, an overly conservative estimate will be derived for the site if it is assumed that all fugitive dust is generated on the site.

4.3.4 Estimation of Average Daily Doses

Intakes of the chemicals from each exposure route and exposure point are estimated using standard chemical intake equations and a combination of standard and site-specific exposure assumptions. The general form of the intake equation is as follows:

$$INTAKE = \frac{Total\ Amount\ of\ Contaminant\ Intake}{(BodyWeight_{average})\ (AveragingPeriod)}$$

Two Intakes are calculated for each exposure route: the intake(year) and the intake(life). The intake(year) is used to evaluate non-carcinogenic effects; it represents the chemical intake during the exposure period and is calculated as the average daily dose over a 365-day period. The intake(life) is used to evaluate carcinogenic effects; it represents the chemical intake averaged over a lifetime and is calculated as the average daily dose over a 70-year lifetime.

The intake equations used in the risk assessment are presented below. These equations are taken from EPA guidance, i.e., Risk Assessment Guidance for Superfund (RAGs), Volume 1 Human Health Evaluation Manual (Part A), 1989.

Dose Equations

Intake for Soil Dermal Contact (Absorbed Dose)

$$\textit{Absorbed Dose } (mg/kg/day) = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW_{avg} \times AT}$$

Where:

CS	=	Chemical Concentration in soil; representative contaminant concentration in soil (mg/kg)
CF	=	Conversion Factor (10^{-6} kg/mg)
SA	=	Skin surface area in contact with soil on days exposed (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Absorption Factor (unitless)
EF	=	Frequency of exposure events (events/year)
ED	=	Duration of the exposure period (years)
BW_{avg}	=	Average body weight of receptor (kg)
AT	=	Averaging time (years)

Intake for Soil Ingestion

$$\textit{Intake } (mg/kg/day) = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical Concentration in soil; representative contaminant concentration in soil (mg/kg)
IR	=	Ingestion rate (mg soil/day)
CF	=	Conversion Factor (10^{-6} kg/mg)
FI	=	Fraction Ingested from contaminated source (unitless)
EF	=	Frequency of exposure events (events/year)
ED	=	Duration of the exposure period (years)
BW_{avg}	=	Average body weight of receptor (kg)
AT	=	Averaging time (years)

Intake for Inhalation

$$Intake\ (mg/kg/day) = \frac{CA\ x\ IR\ x\ ET\ x\ EF\ x\ ED}{BW_{avg}\ x\ AT}$$

Where:

CA	=	Contaminant concentration in air (mg/m^3)
IR	=	Inhalation Rate (m^3/hour)
FI	=	Fraction Inhaled from contaminated source (unitless)
EF	=	Frequency of exposure events (days/year)
ET	=	Average exposure time (hours/day)
ED	=	Duration of the exposure period (years)
BW_{avg}	=	Average body weight of receptor (kg)
AT	=	Averaging period (years)

Intake for Dermal Contact with Chemicals in Water

$$AbsorbedDose\ (mg/kg/day) = \frac{CW\ x\ SA\ x\ PC\ x\ ET\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AT}$$

CW	=	Chemical Concentration in water; representative contaminant concentration in water (mg/liter)
CF	=	Conversion Factor (1 liter/1000 cm^3)
SA	=	Skin surface area available for contact (cm^2)
AF	=	Soil to skin adherence factor (mg/cm^2)
PC	=	Dermal permeability constant (cm/hr)
ET	=	Exposure time (hours/day)
EF	=	Frequency of exposure frequency (days/year)
ED	=	Duration of the exposure period (years)
BW_{avg}	=	Average body weight of receptor (kg)
AT	=	Averaging time (days)

Intake for Ingestion of Contaminated Fish and Shellfish

$$Intake\ (mg/kg/day) = \frac{CF\ x\ IR\ x\ FI\ x\ EF\ x\ ED}{BW\ x\ AT}$$

Where:

CF	=	Chemical Concentration in fish (mg/kg)
IR	=	Ingestion rate (kg/meal)
FI	=	Fraction Ingested from contaminated source (unitless)
EF	=	Frequency of exposure events (meals/year)
ED	=	Duration of the exposure period (years)
BW_{avg}	=	Average body weight of receptor (kg)
AT	=	Averaging time (days)

"Exposure assumptions used in the calculation of average daily doses will be developed based on discussions with U.S. EPA Region I personnel and guidance presented in: 1) *Supplemental Guidance to Risk Assessment Guidance: Standard Default Exposure Factors* (1991); 2) *Risk Assessment Guidance* (U.S. EPA 1989); 3) *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA 1992); 4) Region I specific guidance; and 5) *Exposure Factors Handbook* (U.S. EPA 1989).

The averaging time selected for the calculation of the intakes depends upon the type of toxic effect being assessed. To evaluate acute toxicities, intakes will be calculated by averaging over the shortest exposure period required to produce an effect, usually an exposure event or a day. To evaluate longer-term exposures to non-carcinogenic compounds, intakes will be calculated by averaging over the period of exposure. The exposure period for each of the exposure pathways is shown in Table 4-2. These averaging periods were determined based upon discussions with NSB-NLON personnel. However, in order to be conservative, a seven-year averaging period was assumed for children, even though a typical child remains on base for only six years. If no reliable information was available, the standard U.S. EPA default assumption of 30 years was used for adult civilians. To evaluate exposure to carcinogens, intakes will be averaged over a 70-year lifetime.

4.3.5 Uncertainties Related to Exposure Assessment

Some of the uncertainties associated with the Exposure Assessment components are:

- Exposure point concentrations calculated from analytical data may not accurately represent the concentrations to which receptors can be exposed.
- The value for each chemical intake parameter will be selected to provide a conservative, yet realistic, exposure estimate. However, the use of multiple conservative estimates can result in an estimated chemical intake that may greatly overestimate actual exposures.

4.4 Toxicity Assessment

The health effects of the compounds of concern will be identified and organized in the Toxicity Assessment section of the risk assessment. Evaluation of a compound's potential for toxicity involves the examination of available data that relate its observed toxic effects to doses at which they occur. The effects of exposure will be categorized as non-carcinogenic and/or carcinogenic with regard to human exposure. The known health effects of the compounds of concern on the site will be summarized in brief toxicity profiles. The complete text of these profiles will be included in an appendix in the risk assessment report. A summary table of toxicity values for all compounds of concern will be included in the risk assessment report.

4.4.1 Toxicity Assessment for Non-carcinogenic Effects

With regard to non-carcinogenic effects, it is believed that a dose exists below which no adverse health effects would be expected to occur. This is the threshold dose. U.S. EPA has identified sub-threshold doses or risk reference doses (RfDs) for many compounds. Various types of RfDs are available depending on the exposure route (oral or inhalation), the critical effects, and the length of exposure being evaluated (acute, subchronic or chronic). U.S. EPA has focused on evaluating the consequences of long-term exposure to various compounds and on establishing RfDs for evaluating subchronic and chronic effects. RfD values are expressed in units of milligram of chemical per kilogram of body weight per day (mg/kg/day).

A chronic RfD is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population (including sensitive sub-populations) that does not present an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are used to evaluate the potential non-carcinogenic effects associated with long-term exposure periods between seven years (approximately ten percent of a human lifetime) and a lifetime.

A subchronic RfD is used for characterizing potential non-carcinogenic effects associated with shorter-term exposure periods between two weeks and seven years. Subchronic RfDs are often one order of magnitude higher than chronic RfDs. Chronic and subchronic RfDs for ingestion and inhalation exposures will be obtained from U.S. EPA's Integrated Risk Information System (IRIS) (U.S. EPA 1992e), or from U.S. EPA's Health Effects Assessment Summary Tables (HEAST) (U.S. EPA 1992b), when values are not available from IRIS. For compounds for which there is no published RfD (e.g., for systemic effects due to exposure to carcinogens) U.S. EPA Region I will be contacted to see if more current information is available. For these compounds, a qualitative assessment as to their potential adverse health effects will be discussed.

As reference doses for phenanthrene and acenaphthylene are not available, following Region I guidance, the RfD for naphthalene will be used as a surrogate RfD for the noncarcinogenic PAHs which do not yet have verified RfDs.

Acute effects are those that might occur as a result of short-term exposures occurring over a period less than two weeks in duration. Acute effects might also be manifested during longer-term exposures if individuals are exposed to concentrations that are high enough to result in acute effects. U.S. EPA has not developed RfDs for acute exposures. However, One-Day and Ten-Day Health Advisories developed by the U.S. EPA Office of Drinking Water to evaluate contaminants in drinking water can be used to evaluate oral exposures. These values are based on data describing non-carcinogenic effects and are derived from No Observed Adverse Effects Level (NOAEL) or Low Observed Adverse Effects Level (LOAEL) values.

There are no RfDs available for evaluating dermal exposure. However, following U.S. EPA guidance, the ingestion values for non-carcinogens will be selected for evaluation of dermal exposures until further guidance is recommended. For dermal exposures from soils, the percentages of 2,3,7,8-tetrachlorodibenzo-p-dioxin, 3,3,4,4-tetrachlorobiphenyl and cadmium absorbed are 3%, 6%, and 1%, respectively (U.S. EPA 1992a). The risk from other compounds absorbed through the dermal route from soil will be assessed qualitatively in the uncertainty section of the risk assessment. For estimating the dermally absorbed dose of inorganic compounds per event from surface water, the permeability coefficient from surface water through skin (cm/hr) can be obtained from Table 5-3 in the dermal guidance document (EPA 1992). If there are no published values for specific compounds, the default value of 10^{3} cm/hr will be used. For estimating the dermally absorbed dose of organic compounds from surface water, the permeability coefficient from water through skin from Table 5-7 in the dermal guidance document (EPA 1992) will be used.

The U.S. EPA has accepted the use of the Integrated Uptake/Biokinetic (IU/BK) Model (U.S. EPA 1989) for evaluation of non-carcinogenic exposures to this compound. The model was developed for evaluation of lead exposures to children, but can be used with modifications for adult population exposures as well. The IU/BK Model calculates blood lead levels based on estimated exposure doses of lead to children in various media such as food and water. Potential site-associated exposures will be included as part of the exposure dose used to estimate blood lead levels. The potential for adverse effects can be indicated by elevated blood lead levels. The CDC has recently established a benchmark blood lead level of 10-15 ug/dl (CDC 1991) in children, above which represents a "level of concern." The IU/BK model will be used to determine blood lead levels due to site exposure. The results will be presented in both graphical and tabular form.

The lead uptake/biokinetic model as modified for adults including assumptions and equations are included as Appendix C. We have acknowledged that children are the most sensitive population to the adverse effects of lead, however, since there are toxicological effects seen in adults, the modified model will be used in the uncertainty section of the risk assessment.

4.4.2 Toxicity Assessment for Carcinogenic Effects

The estimates of the carcinogenic potency of compounds are based on the assumption that there are no threshold levels and that the response is linear with dose at low levels (at those encountered in the environment). Thus, there is always some calculable level of risk at every exposure concentration. In evaluating compounds for carcinogenicity, U.S. EPA uses a two-part evaluation in which a weight-of-evidence classification is developed and slope factors or carcinogenic potency factors (CPFs) are calculated for those compounds classified as known, probable or possible human carcinogens. Carcinogenic Potency Factors are measures of the carcinogenic potential of a compound. The CPFs are expressed in units of the inverse of the milligrams of chemical per kilogram of body weight per day $(mg/kg/day)^{1}$. The CPFs for the compounds of concern will be obtained from U.S. EPA's Integrated Risk Information System (IRIS) (U.S. EPA 1992e), or from U.S. EPA's Health Effects Assessment Summary Tables (HEAST) (U.S. EPA 1992d), when values are not available from IRIS. For compounds for which there are no published CPFs, U.S. EPA Region I will be contacted to see if more current information is available. For these compounds, a qualitative assessment as to their potential adverse health effects will be discussed.

There are no CPFs available for evaluating dermal exposure. However, following U.S. EPA guidance, the ingestion values for carcinogens which cause cancer through systemic action rather than direct local action (i.e., changes which produce skin cancer at the point of contact) will be selected for evaluation of dermal exposures, until further guidance is recommended.

As per U.S. EPA Region I guidance, the U.S. EPA-derived cancer potency factor of 7.3 (mg/kg/day^{-1}) for benzo(a)pyrene or the most current CPF will be used as a surrogate for all polyaromatic hydrocarbon carcinogens until further guidance is recommended. Risk estimates based on the relative potency approach as utilized by U.S. EPA Regions II and IV will also be presented in the uncertainty section of the risk assessment.

4.4.3 Uncertainties Related to Toxicity Information

One of the difficulties in carrying out dose-response assessments is that the compounds of concern occur as complex mixtures with varying composition within and among sites. Information on the health effects of an individual compound may not be directly applicable to that compound as it exists as part of a complex mixture. However, in the absence of information to the contrary, the compound-specific information is generally used. It is suggested that until methods are developed that enable investigators to directly assess the toxicity of mixtures or until information is available on synergisms and antagonisms among compounds, the toxicity of mixtures be based on the additive toxicities of the individual compounds.

The toxicity of a compound varies depending on its "form" (or valence state in the case of metals). Chromium may occur in one of two forms: Cr III or Cr VI. The Cr VI state is potentially carcinogenic via the inhalation route whereas the trivalent form is not. To be protective of human health, a worst-case assumption will be made that all of the chromium detected is chromium VI.

4.5 Risk Characterization

Risk characterization involves the integration of health effects information with estimates of exposure to provide a quantitative estimate of risk. The human health risk characterization will estimate the non-carcinogenic and carcinogenic risks from exposure to site compounds currently and in the future.

4.5.1 Quantification of Risks from Individual Chemicals

Quantitative risk estimates and hazard indices will be calculated for carcinogenic and non-carcinogenic effects for each of the exposure pathways analyzed. The equations for the risk estimates and hazard indices will be presented in EXCEL work sheets for each exposure route (i.e., inhalation, ingestion and dermal routes for each exposure group). For carcinogens, risks will be estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen at the site. The carcinogenic potency factor (CPFs) will be used to convert the lifetime estimated daily intakes to incremental risk of an individual developing cancer.

For non-carcinogens, the hazard quotient will be calculated for each compound. This is the ratio of a compound exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period.

Blood lead estimates will be calculated using the U.S. EPA Integrated Uptake/Biokinetic Model. Estimated blood lead levels that exceed 10-15 ug/dl (CDC 1991) warrant further examination and might result in adverse health effects in children. The blood lead level in adults at which adverse health effects occur is believed to be higher than the benchmark for children, although an adult benchmark has not been established.

4.5.2 <u>Quantification of Risks from Multiple Chemicals</u>

Risks will be estimated for mixtures of individual carcinogens and non-carcinogens. Risk estimates for complex mixtures are based on the assumption that the effects may be combined linearly unless there is information to the contrary. In accordance with U.S. EPA guidance, the assumption of additive effects will be made for non-carcinogens in order to calculate a Hazard Index Ratio.

4.5.3 <u>Sources of Uncertainty</u>

In this section, the sources of uncertainty in the analysis and impact that uncertainty has on the results of the assessment will be discussed. Uncertainty analysis will include:

- Assessments of the sources of uncertainty, the soundness of assumptions and the extent to which they were made in a conservative manner, and other qualifying statements that may be appropriate.

- Sensitivity analyses of key assumptions or input parameters.

4.5.4 <u>Summarization and Presentation of the Risk Characterization Results</u>

All calculations of risks will be presented in summary tables. In the case of human health effects associated with exposure to potential carcinogens, risk estimates will be expressed as the lifetime probability of excess cancer associated with the given exposure. Incremental cancer risk estimates and hazard indices will also be illustrated for each receptor using bar charts. Discussions of each of the risks calculated will be included in the report. The results of sensitivity analyses will also be presented in tabular and graphical form.

Blood lead levels for each exposure scenario will be depicted in graphical form. Each bar graph will have a horizontal line drawn at 10-15 ug/dl to illustrate the CDC benchmark value for comparison with calculated blood lead levels.

5.0 ECOLOGICAL RISK ASSESSMENT WORK PLAN

5.1 Introduction

This section provides a brief description of the ecological risk assessment work performed to date and describes the additional work that will be performed as part of this Work Plan. The additional ecological risk assessment work will be conducted according to the U.S. EPA guidance document *Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual* (U.S. EPA 1989), guidance developed by U.S. EPA Region I in their *Supplemental Risk Assessment Guidance for the Superfund Program*, and *ECO Update - Ecological Assessment of Superfund Sites: An Overview* (U.S. EPA 1991). The recent ECO Update provides an overview of the structure of an Ecological Assessment (Figure 5-1) and the role of the assessment in the RI/FS Process (Figure 5-2).

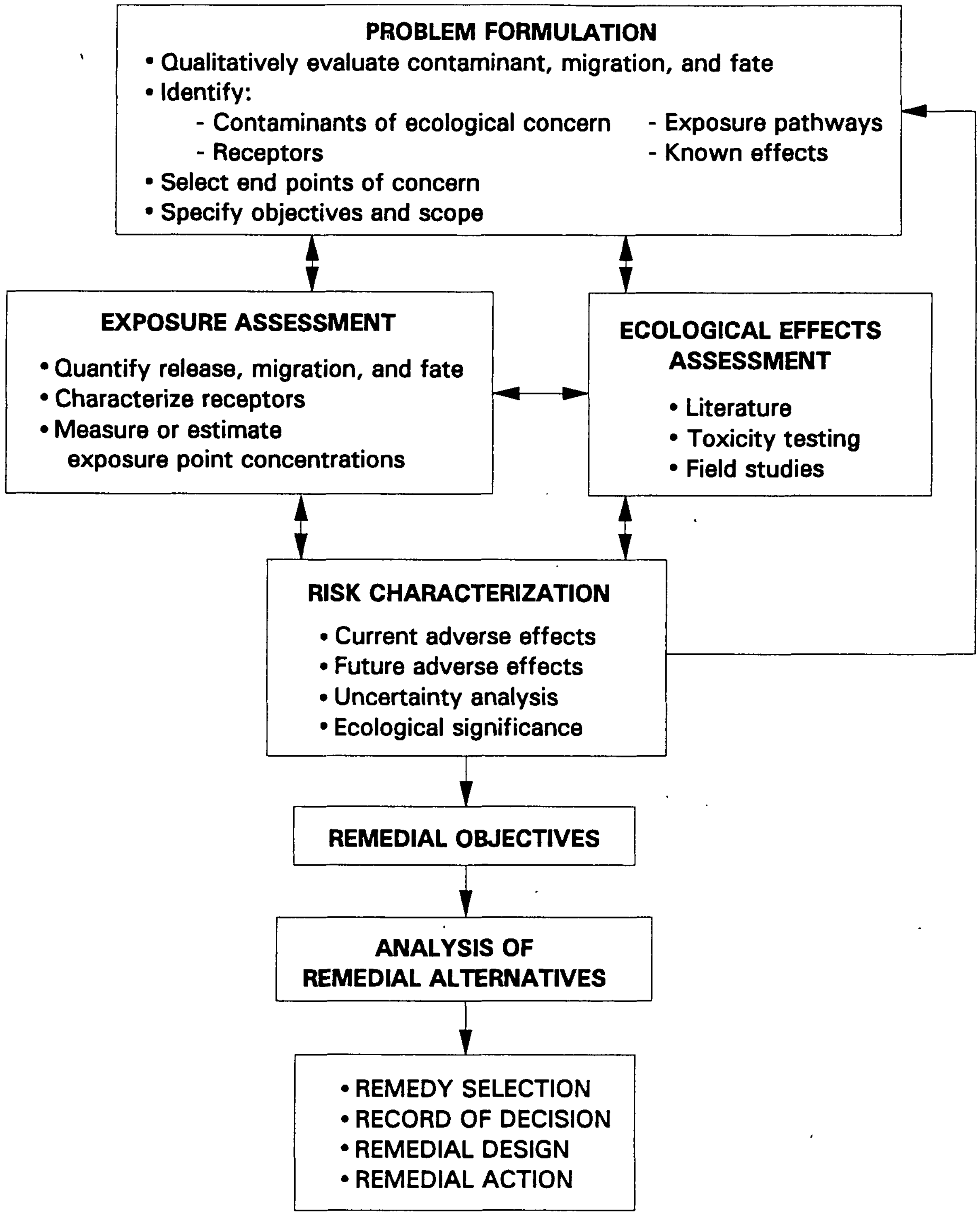
The geographical areas that are the subject of this assessment are in Area A (the Wetland, Downstream, OBDA, and the Weapons Center) and the Thames River in the vicinity of the Subase. The assessment of the Thames River will include Goss Cove.

An ecological risk assessment addressing conditions in the Area A Wetland, Downstream area, and OBDA was previously performed for the Phase I Remedial Investigation (Phase I RI). The studies outlined in this Work Plan are based on recommendations from the previous study and comments from the U.S. EPA and others. The effects of the Subase on environmental conditions in the Thames River were not quantitatively addressed in the previous study. The information gathered under this Work Plan will be incorporated with the previous ecological risk assessment to provide a comprehensive overview of ecological risks due to conditions at the Subase.

The overall objective of the combined ecological risk assessment is to provide supplemental qualitative and quantitative information on environmental risks and/or impacts associated with conditions at the Area A sites (Wetland, Downstream, OBDA, and Weapons Center) and to expand upon previous work to include the effects of the Subase sites on the Thames River. These conditions include the presence of chemical contaminants in soil, stream sediments, surface water, and ground water, and the potential that some of these chemicals are reaching the estuarine environment of the Thames River. Thus, the assessment will consider ecological components within freshwater, estuarine, wetland, and terrestrial environments.

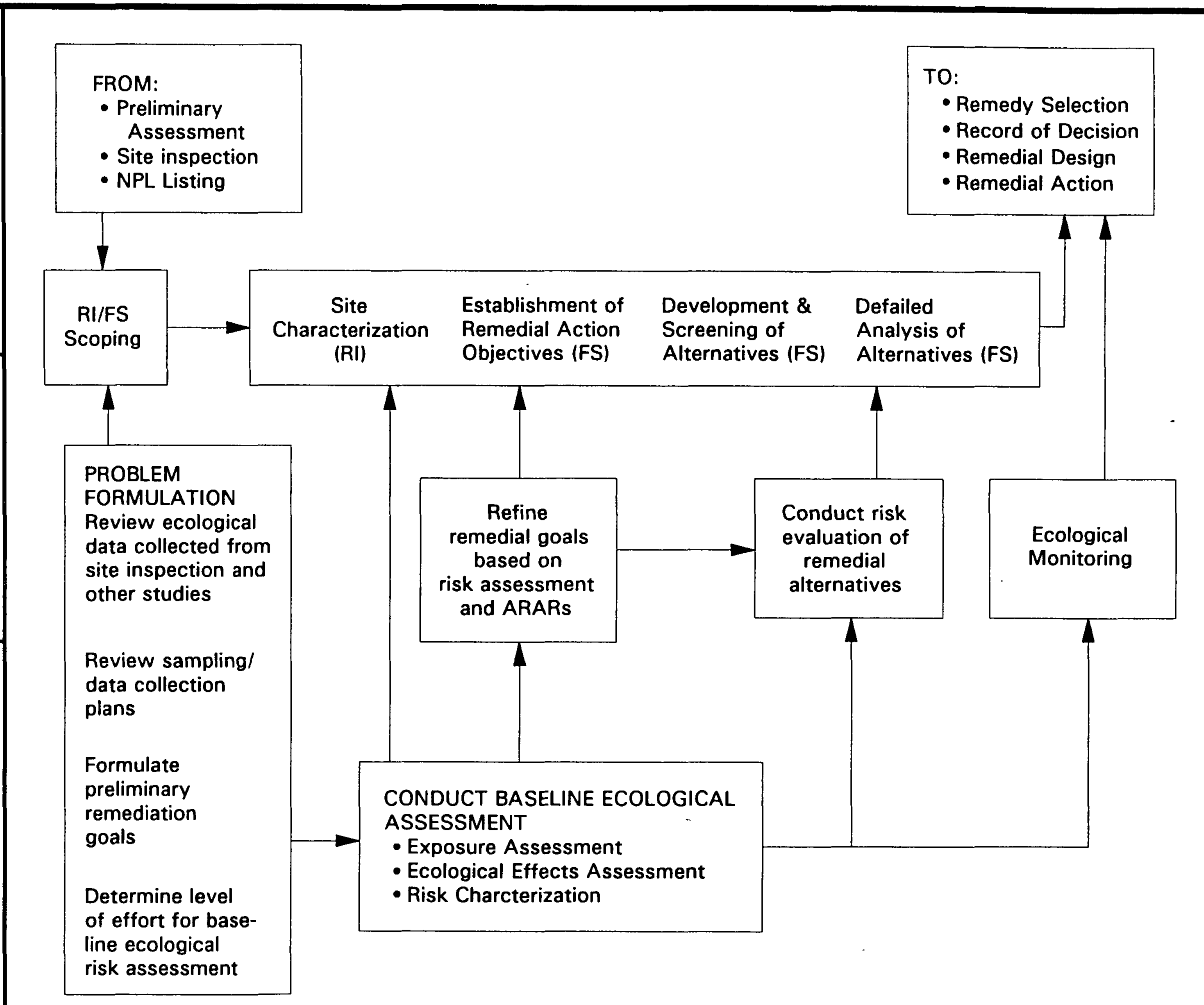
The specific objectives of the overall assessment will be to:

- Identify ecological components or species (e.g., birds, mammals, wetland vegetation, marine organisms) that may be exposed to chemicals associated with existing conditions at the site. Where this was previously addressed for wetland and terrestrial portions of Area A, the objective of this assessment will be to identify ecological components not previously addressed and to obtain additional information on their presence and distribution.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT		FIGURE 5-1 ECOLOGICAL ASSESSMENT OF SUPERFUND SITES: OVERVIEW ATLANTIC ENVIRONMENTAL SERVICES, INC.

FIGURE 5-2
ECOLOGICAL ASSESSMENT IN THE RI/FS PROCESS



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INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

- Select endpoints of concern (e.g., reproduction, survival). Most of this information was developed for terrestrial and aquatic environments of Area A. The present assessment will select endpoints for receptors inhabiting the estuarine environment of the Thames River.

- Identify the pathways and routes by which ecological components may be exposed to the chemicals. Most pathways were identified for Area A components in the Phase I RI. This Work Plan will address additional exposure pathways in Area A if additional ecological components are identified. It will also identify exposure pathways for ecological components in the Thames River.

- Measure or estimate exposure point concentrations using data collected previously and new data.

- Develop information on the toxic effects of the chemicals. Most of this information was obtained for contaminants previously detected in Area A. If contaminants are detected that were not found previously, this assessment will develop data on their toxic effects. In addition, since this assessment includes the Thames River, it will address contaminant effects on estuarine species.

- Characterize the environmental risks associated with exposure under current and future conditions. For Area A, some of these risks were characterized in the previous ecological risk assessment. Therefore, one of the objectives of this Work Plan for Area A will be to combine new data with data obtained and information developed in the previous ecological risk assessment.

- Assess the uncertainties associated with the estimates.

- Discuss the ecological significance of the findings integrating information obtained under this Work Plan with the previous ecological risk assessment performed on Area A.

The ecological risk assessment will use a "weight of evidence" approach which includes direct field observations, selected field and laboratory studies, and evaluation of chemical analytical data relative to environmental benchmarks. When integrated into the overall assessment, these methods will provide a perspective on the nature of ecological risks at the site.

This Ecological Risk Assessment Work Plan has six major sections.

- **Background and Site Description:** This section provides a brief overview of the site and describes what is known concerning the extent of contamination in relation to ecological components. It is a basis for identifying important aspects of the site and data needed to complete the assessment. Much of this information for Area A will come from the ecological risk assessment performed as part of the Phase I RI.

- **Plan for Site Characterization:** This section describes how the site will be characterized relative to ecological components (receptors) and presence of contaminants in media to which the components may be exposed. Much of this information has been previously developed for Area A. Such information is important for all parts of the Ecological Risk Assessment but specifically will be used in the *Problem Formulation* component (Figure 5-1).

- **Plan for Problem Formulation:** This part of the assessment plan describes the approach that will be used to identify contaminants of ecological concern, ecological components (receptors) for evaluation, endpoints of concern, exposure pathways, and known effects. Much of this information was developed previously for Area A. The *Problem Formulation* will provide the basis for proceeding with the subsequent portions of the Ecological Assessment.

- **Plan for Exposure Assessment:** This section of the assessment plan describes the general approach to be used to complete the exposure assessment. Specific methods will depend on the results of the Site Characterization and Problem Formulation.

- **Plan for Ecological Effects Assessment:** This section describes the approach that will be used to develop information on the toxicity of the contaminants to environmental components. Again, much of this information was developed previously for Area A.

- **Plan for Risk Characterization:** This section describes the general methods that will be used to make qualitative and quantitative characterizations of risk and indicates how uncertainties will be characterized.

5.2 Background

Sections 2.0 and 3.0 of this Work Plan provide detailed background information on the sites included in the Phase II RI. Section 2.0, Evaluation of Existing Data, provides a description of the sites and existing chemical contaminant data. Section 3.0, Site Dynamics, describes the environmental fate and transport of site-related contaminants. This section (5.2) of the ecological risk assessment work plan provides sufficient background information on these sites to support the proposed scope of work.

Area A (Wetland, Landfill, Downstream/OBDA and Weapons Center) is a Supplemental Step II site. Information obtained during the course of these investigations will be integrated with the results of the previous Phase I RI to provide a comprehensive ecological risk assessment for these areas.

Of the new Step II Investigation sites, only the Rubble Fill at Bunker A-86 and Goss Cove are located in areas that are likely to have ecological components. The Torpedo Shops and Spent Acid Disposal Area are developed and are unlikely to be frequented by wildlife.

5.2.1 Area A

Area A includes the Landfill, Wetland, the areas downstream of the dike in the Area A Wetland and associated ponds and streams (Downstream), OBDA, the Weapons Center, and Rubble Fill at Bunker A-86. The Weapons Center and the Rubble Fill at Bunker A-86 are included in this assessment since they border on Area A and contaminants present or migrating from these areas may have an effect on ecological conditions in Area A.

5.2.1.1 Description

Area A consists of mostly undeveloped land running from the Perimeter Security Road in the east to the Thames River in the west. The eastern half of Area A consists of an approximately 30 acre wetland that was once used for dewatering and disposal of dredge spoils. The predominant form of vegetation in the wetland is the common reed, *Phragmites*. The wetland is bordered by the Weapons Center to the north and the Area A Landfill to the south. A small pond is in the southern portion of the wetland north of the landfill.

A dike separates the eastern and western portions of Area A. The downstream part of Area A is bounded by Triton Road to the north and Wahoo Avenue to the south. Except for the streams that flow from this area, the western limit of the downstream area is the fence east of North Lake. This fence separates the developed portion of Area A Downstream from the forested area. North Lake, the Officers Club, and the golf course occupy the developed part of this area. Most of the undeveloped area is upland deciduous forest.

OBDA is a very small area within the Area A Downstream at the bottom of a steep slope once used as a disposal area. Currently, vegetation in the area is predominantly *Phragmites*.

Three streams flow through the downstream area toward the west. The first begins at the dike and flows into a small pond approximately 200 feet downstream. Water from this pond flows into culverts along and under Triton Road. Storm drains from the Torpedo Shops flow into the culverted stream along Triton Road. The stream exits the culvert south of the Torpedo Shops, flows along Triton Road, under Shark Boulevard, and is discharged to the Thames River at DRMO.

A second stream begins at OBDA and flows west toward North Lake. It flows into a culvert before it reaches the fenceline east of North Pond. The culvert diverts the flow past North Lake, through the golf course (open watercourse), and out to the Thames River.

A third stream begins at a small pond in the center of the Area A Downstream. Flow from this stream is also diverted through a culvert to the west side of North Lake where it joins the second stream.

5.2.1.2 Results of Previous Work

The Phase I RI in Area A included sampling and analysis of soil, sediment, surface water, and ground water. It also included a qualitative wildlife survey performed by a wildlife biologist, sampling of frogs from the pond in the wetland and downstream watercourses, and sampling of fledgling catbirds. The tissues of the frogs and catbirds were analyzed for pesticides and metals.

Inorganic contaminant levels in soils and sediments were compared to published background concentrations. Concentrations of organic compounds were compared to biological effects levels for soil and sediment invertebrates via an equilibrium partitioning approach. Potential effects to higher trophic level species were assessed via a food chain model.

Results of the ecological assessment performed in Area A indicated that DDT and its residues (DDTR) in soil at OBDA and in stream and pond sediments in the Downstream pose a risk to soil and benthic invertebrates. DDTR may also pose a risk to higher trophic level species (e.g., small carnivorous birds and mammals) that use invertebrates as a source of food. DDTR levels in fledgling catbirds and frogs were low. However, the frogs were not collected from the streams and ponds with elevated DDTR concentrations.

Recommendations for additional studies were made based on the results of the previous ecological risk assessment. Additional suggestions for studies resulted from U.S. EPA Biological Technical Assistance Group (BTAG) review of the previous assessment. These recommendations for Area A are:

- Additional soil sampling and analysis in the Area A Downstream to better assess DDTR concentrations in this area.

- A biological assessment of the ponds and streams in the Area A Downstream to document benthic and stream conditions in areas where the previous risk assessment predicted risks due to DDTR in sediments.

- Sampling and analysis of sediment from the pond in the Area A Wetland and the open water area near the wetland outlet for DDTR to assess levels detected in frogs in these areas.

- Assess the effect of DDTR transported downstream from the Area A Downstream on the Thames River as well as the cumulative impact of ground water discharges from the sites along the river.

5.2.2 Thames River and Goss Cove

The Phase I RI included sampling and analysis of Thames River water and sediment at a few locations and a qualitative assessment of the effect of contaminated ground water discharge from the sites along the river. This Work Plan will include sampling of Thames River biota and an assessment of potential cumulative impacts on the river associated with surface water and ground water discharges from the Subase. An assessment of Goss Cove will be included.

5.2.2.1 Description of Goss Cove

Goss Cove, along the Thames River at the southwest end of the Subase, is separated from the Thames River by a Providence and Worcester Railroad embankment. The northern half of Goss Cove was once used as a landfill. The history of landfilling is reviewed in Section 2.0 of this Work Plan. The northern half of Goss Cove is currently the site of the Nautilus Museum and adjacent parking lot. The southern half of Goss Cove remains as a surface water body separated from the Thames River by the Penn Central Railroad. The cove has no outlet, but it is hydraulically connected to the river through the railbed.

5.2.2.2 Results of Previous Work at Goss Cove

Previous work at the site performed as part of the Phase I RI consisted of soil borings, monitoring well installation, soil and ground water sampling and analysis, and a soil gas survey. Details are in Section 2.0 of this Work Plan. Results indicated the presence of VOCs, PAHs, PCBs, pesticides, and elevated metals concentrations in soil, and VOCs and the lighter PAHs in ground water. Previous work did not include sampling and analysis of water or sediment or an ecological assessment of the unfilled portion of Goss Cove.

5.2.2.3 Description of the Thames River

The Thames River is a tidal estuary formed at the confluence of the Shetucket and Yantic Rivers in Norwich, Connecticut. It flows approximately 16 miles to Long Island Sound to the south. The Subase and the town of Groton are on the east bank of the river approximately 6 miles north of Long Island Sound. The City of New London is on the west bank of the river.

The Thames River is a salt wedge estuary. Depending on the time of year and climatological factors, the river can be highly stratified with freshwater on the surface and denser saline water on the bottom. Welsh (1984) estimated a freshwater flushing time of 0.5 to 2 days from Norwich to Long Island Sound. In comparison, he estimated a flushing time for bottom water of greater than 19 days.

Land development along the southern portion of the river is mostly industrial. Chemical companies, oil terminals, power plants, and waste water treatment plants occupy both banks of the river.

The CTDEP classifies the Thames River as SC/SB. This indicates that the river currently does not meet the goals for an SB water body (i.e., suitable for swimming and harvesting of shellfish and desirable to promote the restoration of an anadromous fishery). It is noted that CTDEP is currently considering changing the water classification to SC/SA.

A dredged channel runs north to south in the river. Depths in the dredged channel are approximately 40 feet below mean sea level. At the Subase, the width of the river ranges from 1500 to 3000 feet.

5.2.2.4 <u>Summary of Existing Thames River Data</u>

Extensive data on water and sediment quality and fisheries exist for the Thames River. The Draft Environmental Impact Study (EIS) for the Thames River Dredging Project prepared by the Department of the Navy in March 1991 was the main source of information for this summary.

<u>Water Quality</u>: Applied Sciences Associates (ASA), in conjunction with the CTDEP, have developed a box model to evaluate water quality in the Thames River. Extensive water quality and hydrographic data for the Thames River have been collected by the CTDEP and ASA for use in calibrating the model.

During sampling performed for the EIS in the summers of 1989 and 1990, dissolved oxygen (DO) concentrations in the vicinity of the Subase were around 6 mg/l. Areas farther upstream had lower DO concentrations.

Salinity and temperature data from July 1989 show that the river was highly stratified. In the vicinity of the Subase, the bottom temperature was 19°C while the temperature of water at the surface was 24°C. A marked salinity gradient was evident at a depth of approximately 4 feet. Salinity on the surface was 12 parts per thousand (ppt), while bottom water had a salinity of 28 ppt.

Project Oceanology (1989) collected data on nitrate and ammonia concentrations in the river. Their data indicate that nitrate concentrations are much greater in surface water than bottom water. Nitrate concentrations increase with distance from the river mouth. In the vicinity of the Subase, nitrate concentrations range from 10 to 27 micro molar (uM) in the surface water while the concentration in bottom water is approximately 2 to 3 uM. Ammonia concentrations are much more consistent throughout the water column and are in the range of 5 to 10 uM.

Project Oceanology also measured chlorophyll concentrations above and below the pycnocline to assess the contribution of phytoplankton to hypoxic conditions in bottom water of the estuary.

<u>Sediment Quality</u>: Limited sediment sampling and analysis in the Thames River was performed as part of the Phase I RI. Samples were collected at each of the two outlets of the watercourses from Area A. Chemical analysis of these samples detected PAHs (up to 10 ppm) and low levels of DDT (0.068 to 0.120 ppm) in both samples, and 0.280 ppm of PCBs in one sample.

Most of the existing information on sediment quality in the Thames River has been generated in support of dredging projects. The most comprehensive data set is from the EIS (referenced above) that was performed in anticipation of dredging for the Sea Wolf project.

Sediment sampling and analysis performed for the EIS indicated that channel sediments consist of dark grey and black clayey silts. The organic content of the sediments ranges from less than 1 to 5 percent. Project Oceanology measured organic carbon in sediments in the summer of 1989 and found 2 to 4 percent organic carbon from sediment samples collected from the vicinity of the Subase. In the vicinity of the Subase, the silt and clay fraction of sediment samples ranged from 30 to 60 percent. In many locations in the estuary, the surficial sediments were anoxic.

Results of chemical analyses of sediment samples collected from the portion of the river proposed to be dredged and reported in the EIS indicated that total petroleum hydrocarbons were elevated in a few locations (up to 589 ppm). In general, metals concentrations were not elevated and low levels of a few PAHs were detected in most samples.

Other available information on sediments in the vicinity of the Subase includes chemical and physical analyses performed in support of small dredging and construction projects.

Results from analysis of four sediment samples composited over depth from two cores obtained by Morrison Geotechnical Engineering in 1989 in the vicinity of Pier 26 indicated slightly elevated levels of copper and zinc in one sample. The organic content of the samples ranged from 2.1 to 4.9 percent. PCBs and pesticides were not detected. PAH concentrations ranged from 48.4 to 255 ppm.

Morrison Geotechnical Engineering (MGE 1990) obtained four sediment cores in the vicinity of Pier 33 at the Subase in 1990. Samples from the cores were analyzed for physical and chemical parameters. Results indicated that the predominant grain size fraction in all but one of the samples was sand (49.1 to 58.1 percent); silt comprised 8.9 to 18.3 percent of the samples. Metals concentrations were not elevated. Elevated levels of petroleum hydrocarbons (54 to 409 ppm) and low to moderate levels of PAHs (0.414 to 9.47 ppm) were detected in the samples.

Benthic Organisms: The benthic survey for the Draft EIS document was performed in March 1990. The Draft EIS document compared data collected during that survey with previous benthic surveys performed in the Thames River.

Benthic communities in the Thames River differ from south to north and between channel and non-channel areas. Since most of the benthic surveys of the Thames River have been performed in anticipation of dredging, most of the work has focused on the channel. The benthic communities south of the I-95 bridge (2 miles south of the Subase) are more representative of Long Island Sound. Benthic abundance and species richness decreased from the mouth of the river north to the Subase as is expected in an estuary. Species composition is similar north of the bridge, but abundances are lower, likely due to the shallower, less saline water in this area.

The channel is dominated by several taxa, including the bivalves *Mulinia lateralis* (the opportunistic Coot Clam) and *Nucula proxima*, and the polychaetes *Nephtys incisa* and *Mediomastus ambisecta*.

Welsh and Stewart (1984) also found differences in benthic communities in the channel north and south of the I-95 bridge. North of the bridge, they found predominantly *Nephtsy ceaca*, *Potamilla reniformis*, *Pectinaria gouldii*, *Yoldia limatula* and epibenthic species Hardshell Clam (*Mercenaria mercenaria*), *Crangon septispinosa*, and *Asterias forbesii*, a starfish. This was similar to what Tolderlund found in 1975.

In the summer of 1989, Project Oceanology identified *Nucula proxima*, *Yoldia limatula*, *Nephtys incisa*, and *Mulinia lateralis* as the most common and abundant species in areas of the estuary where the sand content of the sediments was less than 40 percent.

Predominant species found by Welsh and Stewart outside the channel in 1984 differed from those found in the channel. Outside the channel they reported: the polychaetes *Scoloplos robustus*, *Pectinaria gouldii*, and *Sabellaria vulgaris*, and epibenthic species such as Softshell Clams (*Mya arenaria*), Hardshell Clams, the amphipod *Gammarus oceanis*, the gastropod *Illyanassa obsoleta*, shrimps *Paleomonetes pugio*, *Crangon septenspinosa*, *Crangon septenspinosa*, crab *Callinectes sapidus*, and starfish *Asterias forbesii*.

Fisheries: Abundant fish species in the Thames River include Winter Flounder, Tomcod, and Window Pane Flounder in the deeper channel areas and Mummichog and Striped Killifish near shore. According to enquiries made for the draft EIS, no endangered species of fish have been reported in the Thames River.

The Thames River also serves as a feeding area for long range coastal migrants such as Menhaden, Bluefish, Striped Bass, and Mackerel, and seasonal migrants such as Tautog, Weakfish, Porgy, and Whiting. The River Herring, an anadromous fish, is also a seasonal migrant.

According to a report by the Senior Environmental Sanitarian for the Town of Waterford, Connecticut (Citak 1991), most of the Thames River is closed to shellfishing due to contamination by fecal bacteria. Shellfish beds in a few areas of the Thames River are open to shellfishing on a conditionally restricted basis. This means that shellfish from these areas must be relayed to and held in approved waters for 30 days when the water temperature is greater than 50°F. Shellfish in these beds are Hard-Shell Clams and Oysters. The conditionally restricted shellfish beds are in Waterford, Connecticut waters from the Montville, Connecticut town line to the north to the New London city limits to the south, and include the area around Mamacoke Island on the west bank of the Thames River opposite the Subase (Refer to Figure 1-2). There are also conditionally restricted shellfish beds north of the Subase in Ledyard waters. Some commercial lobstering also occurs in the river.

5.3 Plan for Site Characterization

5.3.1 Objectives

Site characterization is an important part of the Problem Definition/Scoping of an ecological risk assessment. The primary objectives of this section are to address site characterization data gaps from the previous risk assessment and provide additional information. The site characterization:

- Identifies the types and spatial extent of habitats that are present on and around the site. This was done previously for terrestrial and aquatic habitats in Area A. This Work Plan also discusses the estuarine habitat of the Thames River.

- Identifies the species and biological communities that may use these habitats and that may be potential receptors with regard to contaminated media such as soils, sediments, and surface waters. This information will be developed for the Thames River and augmented for Area A.

- Evaluates the extent and nature of contamination of media with regard to potential exposure of species and biological communities. To meet this objective, contaminant data resulting from the tasks outlined in this Work Plan will be combined with data collected during the Phase I RI.

5.3.2 Characterization of Terrestrial and Freshwater Habitats in Area A

5.3.2.1 Overview

The previous ecological risk assessment performed at the site identified the nature and composition of aquatic and terrestrial animal and plant communities in the vicinity of Area A. This section of the Work Plan outlines the approach that will be used to fill existing data gaps and gather additional information. The estuarine system of the Thames River will be characterized separately (Section 5.3.4).

The terrestrial habitat at and in the vicinity of Area A was characterized previously. Additional information will be gathered on certain aspects of the terrestrial and aquatic habitat such as: the presence of rare, threatened, and endangered species; the abundance of certain terrestrial (soil invertebrates) and aquatic species (benthic invertebrates, frogs, and fish); and the condition of certain species and their body burden of contaminants.

These tasks will be accomplished by conducting a review of rare, threatened and endangered species; *in situ* bioassays using earthworms; and qualitative field surveys of area fauna such as soil invertebrates, benthic invertebrates, fish, and frogs. Table 5-1 summarizes the ecological field sampling that will be performed for Area A. The ecological field sampling and analysis is further described herein. The final report will integrate this information with the results of the wetland delineation and previous ecological information developed for Area A. These data products will be used in the exposure assessment and characterization of risk.

5.3.2.2 Review Of Rare, Threatened And Endangered Species

As part of the site characterization, federal or state rare, threatened and endangered species which may inhabit the site will be identified. Identification of these species will assist in the development of important ecological receptors. CTDEP, Connecticut Natural Heritage Program, and United States Fish and Wildlife Service (USFWS) will each be contacted for this information. If rare, threatened or endangered species are identified, maps will be provided at appropriate scales to show potential habitat or nesting sites for these species. Natural histories

TABLE 5-1
AREA A SUMMARY OF ECOLOGICAL SAMPLING

Sample Type	Location	Sample Quantity				Analysis
		Tissue	Soil	Sediment	Bioassays	
Area A - Qualitative Survey						
Qualitative soil invertebrate survey	Wetland, Downstream, OBDA					Qualitative
Fish	Downstream ponds	•[1] (3)				Qualitative/Pesticides
Area A - Quantitative Survey						
Native earthworms and soils	Downstream	• (5)	• (5)[3]			Pesticides
In situ earthworm bioassays in soils/wetland sediment	Wetland, Downstream, OBDA				• (15-20)	---
Introduced earthworms from bioassays and soils/wetland sediment	Wetland, Downstream, OBDA	• (5)	• (5)[3]			Pesticides
Earthworm bioassays in pond sediment	Downstream watercourses			• (6)[3]	• (9)[2]	Pesticides (sediment only)
Introduced earthworms from bioassays	Downstream watercourses	• (3)				Pesticides
Frogs	Downstream ponds and streams	• (9)				Pesticides
Benthic Invertebrates and reference location	Downstream ponds and streams	• (18)		• (18)[3]		Quantitative benthic analysis, reference area sediments for pesticides

Notes:
1 If larger fish are found, separate analysis will be conducted for tissue and liver for a total of six analyses.
2 Includes three reference locations.
3 Analysis included in Area A field sampling plan.

of these species will also be developed through literature searches and discussions with the previously mentioned agencies.

5.3.2.3 Additional Terrestrial Field Assessments

The purpose of this task is to provide additional qualitative field verification of the types of terrestrial soil invertebrates in Area A, potential effects of contaminants in soils on these invertebrates, and an indication as to the amount of contaminants to which higher trophic levels may be exposed. The following analyses will be conducted:

- observations of the presence or absence and species composition of soil invertebrates

- *in situ* earthworm bioassays incorporating visual observations of stress or mortality

- measurements of bioaccumulation in native and introduced earthworms

Qualitative Soil Invertebrate Survey: The abundance of soil invertebrates will be noted qualitatively for the Area A Wetland and the forested portion of Area A Downstream. These areas will be walked over by a biologist, with special attention placed on suitable habitats (e.g., moist areas under rocks or fallen trees). As the walkover occurs, the biologist will take samples of soil using a shovel. The soil will be sieved in the field and then qualitatively examined for the types and frequency of soil invertebrates. The survey will be qualitative rather than quantitative, since the objective is to provide an inventory of terrestrial invertebrates onsite in Area A, rather than to provide data for assessment of population structure or community analyses. The field biologist will also visually categorize the soil as either silt, clay, or sand/gravel. Observations will be recorded in a field log book.

Bioaccumulation in Native Earthworms: If native earthworms are observed in the forested portion of Area A Downstream, five earthworm samples (each composed of approximately 25 grams of earthworm tissue) from this area will be collected, washed with distilled water, and placed in glass jars. Other soil invertebrates will be collected if earthworms are not observed in this area. Earthworm samples and associated soil samples will be analyzed for pesticides. Locations will be coordinated with surface soil samples collected for the Area A field sampling plan so that comparisons can be made between concentrations of contaminants in soil and earthworm tissue and information obtained on bioaccumulation of contaminants.

***In Situ* Earthworm Bioassays:** *In situ* earthworm bioassays (15 to 20) will be performed in the Area A Wetland and the forested portion of Area A Downstream. Two bioassay stations will be located in the Area A Wetland in the vicinity of Phase I stations 2WSD5 and 2WTB3. The results of sampling and analysis performed for the Phase I RI indicated that pesticides were not detected in surficial soil samples from these locations and that, in general, soil in the wetlands had low concentrations of DDTR compared to sediments in Area A Downstream. Therefore, these two stations will serve as reference locations.

The remaining bioassay stations will be located in the forested portion of Area A Downstream. Locations will include two stations near each pond and two stations each near the streams exiting these ponds. Other locations will be chosen in low-lying areas subject to seasonal flooding. The locations will be chosen to coordinate the results of the bioassays with contaminant concentrations measured in surface samples collected during the previous assessment and during sampling activities described in the Area A field sampling plan. These bioassays are intended to provide insights into the potential stress on soil invertebrates and higher trophic levels due to contaminants in these areas.

The bioassay procedure consists of placing ten healthy *Lumbricus terrestris* and site surface soil (or sediment) in a mesh-enclosed chamber that prevents the escape of specimens while allowing for the vertical passage of water and air. The chamber consists of thick PVC tubing, approximately 8 inches in length and 4 inches in diameter, enclosed on either side by mesh. Surface soils (0 to 6 inches) from a particular station are placed into the chamber along with *L. terrestris*. A reference chamber is also employed using an artificial soil composed of sterile silica sand (68%), kaolin clay (20%), peat moss (10%), and pulverized calcium carbonate (2%) as substrate (Callahan and Wilborn 1988). Holes large enough to allow for the insertion of each chamber will be dug at each station. The chambers are placed into the holes with the top of the chambers level with the surrounding soil. After 14 and 28 days, the chambers will be opened and the specimens examined. If any of the worms have died after 14 days, they will be removed from the chamber. The biologist will log the number of remaining worms in a field notebook in addition to the number of dead worms for each site and reference chamber. The general health of the worms and the occurrence of sub-lethal effects such as coiling or swelling will be noted.

Introduced Earthworm Bioaccumulation: After 28 days, the remaining living earthworms and approximately 0.5 kg of soil will be removed from the site chambers for five of the bioassay stations. Stations will be selected based on the results of the earthworm bioassays. Earthworms will be washed with distilled water and placed into glass jars. Soil samples will be placed into separate glass jars. Samples will then be placed in a refrigerated cooler for preservation. For each station, earthworm samples will be homogenized and analyzed for pesticides. Associated soil samples would also be analyzed for pesticides. This information will be used to estimate pesticide bioaccumulation factors. The soil analyses are included in the Area A field sampling plan.

5.3.2.4 Additional Assessment of Freshwater Systems in Area A

The sampling defined in this task intends to more clearly identify the types of aquatic species present in Area A freshwater systems. This will assist in the selection of important receptors for the risk assessment and indicate the degree to which contaminants are bioaccumulating within the food chain. This task consists of:

- in-field earthworm bioassays using sediments obtained from the downstream ponds

- analysis of frog tissue from downstream ponds for pesticides

- a qualitative fish survey to assess whether fish inhabit the downstream area ponds and to identify species, if fish are present in the ponds

- a quantitative benthic survey in the downstream watercourses to assess the condition of the benthos and community parameters

Earthworm Sediment Bioassays: Laboratory bioassays will be performed using Area A pond sediments. Two of the sediment samples from each of the three small ponded areas (for a total of six bioassay sample locations) in Area A Downstream will be used as substrates for the earthworm bioassays. Sediment samples (six) will also be analyzed for pesticides. Locations will correspond to sediment sampling locations in the Area A field sampling plan.

Sediment samples will be returned to the laboratory where the bioassays will be conducted. Depending on sediment type and expected contaminant concentrations, samples will be mixed with reference sediment to provide appropriate moisture and organic content for the earthworms. Where possible, assays will be performed with 100 percent sediment, sediment mixed with 50 percent reference sediment, and 100 percent control reference sediment. Bioassay methodologies will be those developed by EPA (Callahan and Wilborn 1988). Prior to performing these bioassays, the methodology including the test species will be submitted to the EPA BTAG for approval. Test chambers will be observed after 24 hours and every seven days to ensure that the worms are burrowing into the sediment. The chambers will be examined after 14 and 28 days for earthworm mortality and sub-lethal effects.

After 28 days, earthworms will be removed from the test chamber from each of the three ponded areas, washed, composited by pond (to create one composite sample from each pond for a total of three earthworm samples) and stored in glass jars. Earthworm samples will be homogenized and analyzed for pesticides. Results will include percent moisture.

Frog Body Burdens: Adult frogs will be captured for pesticide analysis using nets or baited hooks. The species of frog will be recorded. The collection effort will focus on year-round resident species such as Green Frog. This species was observed in Area A during previous work at the site in April 1990.

Frogs will be captured from the three small ponded areas of the downstream section of Area A: the ponded area in OBDA, the pond just to the north of OBDA, and the pond to the northwest of OBDA. Frogs will be killed using a non-chemical method, placed in aluminum foil, and kept on ice or refrigerated. Three frogs will be caught from each of the three ponds (nine samples total). The biologist will note the location of each frog caught, its length and weight, and any external pathology. Each frog will be homogenized (whole body) and analyzed for pesticides. Results will include percent moisture.

Qualitative Fish Survey: A qualitative fish survey will be conducted in the three small ponded areas in the downstream section of Area A. The purpose of this effort will be to assess whether there are fish present in these ponds, and if present, to identify the species and measure body burdens of contaminants. Because these ponds are relatively shallow and weedy, electroshocking will be used to obtain fish samples. While an electroshocking technician operates in each pond, a field biologist will note the number and types of species which surface. If fish are found in number, a sufficient quantity of fish from each pond to comprise three tissue samples will be collected, weighed and measured. These tissue samples will be analyzed for pesticides. Any external pathology will be noted in the field notebook. Each sample will be wrapped in aluminum foil, tagged for identification, and refrigerated. If larger fish are found, fillets and livers will be removed from the fish and analyzed individually for pesticides (six samples). Percent moisture will also be measured and reported.

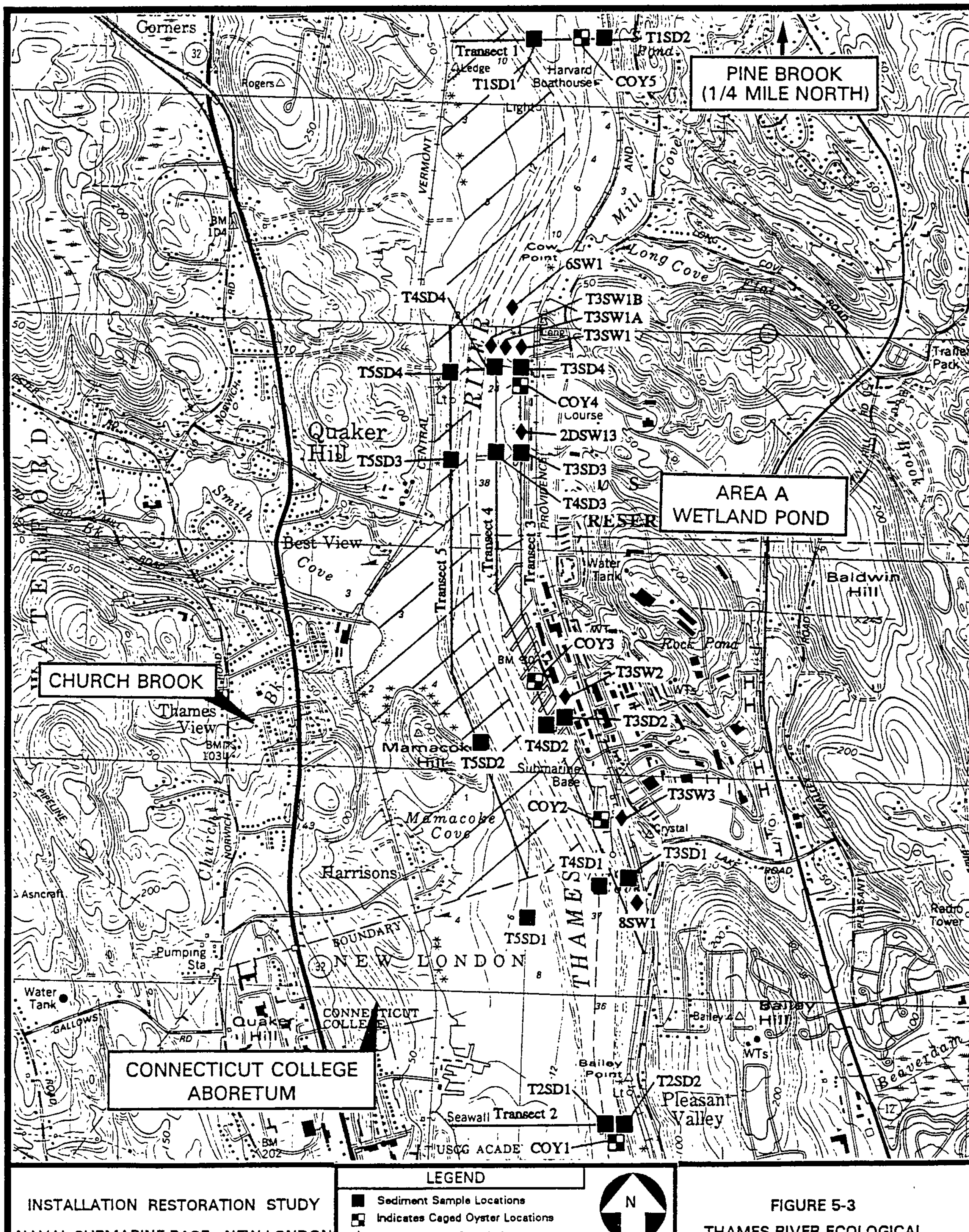
Quantitative Benthic Survey: A quantitative benthic survey will be conducted at the three ponded areas and directly downstream to assess the condition of the benthic invertebrate biota of the sediments. Thirteen locations will be sampled. Two locations will be selected in each of the two ponds and the wet area in OBDA for a total of six pond locations. A sample will be collected from the center and edge of each pond. Two locations in the streams directly downstream of these areas and the stream exiting the dike before it flows into the upper pond will also be sampled for a total of seven stream locations. These locations will correspond to locations sampled and analyzed in the Area A field sampling plan so that comparisons may be made between concentrations in sediment and observed benthic community parameters.

A reference pond and reference stream will also be sampled. Reference areas will be chosen that have similar morphology (e.g., substrate, water depth, hydrology, etc.) to the ponds and streams in the Area A Downstream. Two benthic samples will be collected from the reference pond; three samples will be collected from the reference stream (five total). Sediment samples from the reference areas will be analyzed to ensure that contaminant concentrations are low relative to levels detected in the ponds and streams in the Area A Downstream.

The pond under consideration as a reference area is the pond in the Area A Wetland. Other reference areas under consideration are Church Brook, ponds and streams within the Connecticut College Arboretum in New London and Pine Brook in Ledyard (Figure 5-3). Exact locations will be based on a field reconnaissance of the candidate areas. Approval from the Navy and EPA BTAG for the reference locations will be sought prior to sampling.

Benthic sampling and processing will follow standard methods (APHA 1985). The benthic samples will be obtained with a petite ponar sampler, kick net, or surber sampler, depending on the substrate. Each stream station will be sampled at approximately mid-channel. Upon retrieval, the sampler will be emptied over a 5-gallon polyethylene bucket. The sample will then be sieved and the biota will be placed in a 1-liter jar which will be labelled with station number, date, time, and sample identification number. Each biological sample will be preserved in 10 percent buffered formalin and stained with rose bengal. Data collection sheets filled out at each sample location will include: date collected, method of collection, sample location (waterway and nearest prominent landmark), sample depth, sediment type (general description of gravel, sand, and silt content), sample identification number, and time of collection.

Samples will be delivered to the laboratory under chain of custody and sorted to gross taxonomic category. Subsequently, individuals will be identified to the lowest taxonomic category which can be practically achieved.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND ■ Sediment Sample Locations Indicates Caged Oyster Locations ♦ Surface Water Sample Locations Commercial Shellfish Beds PINE BROOK Potential Reference Areas For Benthic Sampling Shading indicates Conditionally Restricted Shellfishing area Locations are approximate, exact locations will be chosen in the field SOURCE: U.S.G.S. Topographic Map, 1984 Uncasville, Ct.	FIGURE 5-3 THAMES RIVER ECOLOGICAL SAMPLING LOCATIONS ATLANTIC ENVIRONMENTAL SERVICES, INC.

Benthic data will be interpreted based upon simple community parameters. These will include: numerical density, numerically dominant species, species evenness, and number of species. In addition, the Hilsenhoff Biotic Index will be calculated for each sampling station. Information will be obtained from the Connecticut DEP regarding the use of this index in Connecticut and tolerance values assigned to particular taxa in this geographic area. These parameters will provide comparisons with expected ranges from similar aquatic environments. The comparisons will provide information on the general ecological conditions within the streams and ponds at the site.

5.3.3 Wetland Delineation

Wetlands surveys will identify wetlands within the Area A site based on federal and Connecticut State classification guidelines. All surveys will be conducted by a Connecticut State Certified Soil Scientist. The delineation of wetlands by federal definition will be conducted according to the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, 1987, unless the 1991 Unified Federal Manual is finalized by the time of the survey. In that case, the plan will be amended to use this more recent manual. Delineation of wetlands by Connecticut State definition will include, as defined in 22a-38 of the Connecticut State regulations, submerged land, not regulated pursuant to Sections 22a-28 to 22a-35, inclusive, which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial, and flood plain by the National Cooperative Soils Survey, as may be amended from time to time, of the Soil Conservation Service (SCS) of the United States Department of Agriculture.

Prior to initiating field activities, various maps and surveys will be examined, as available. This information may include: aerial photographs, USFWS National Wetlands Inventory Maps, United States SCS soil survey maps, USGS maps, and site maps.

The field work will involve wetland delineation by placing flags along the wetland/non-wetland boundary close enough for accurate surveying and mapping (about every 50 feet). Field notes will be recorded on field logs. Field notes will be transferred to approved data sheets and included in an appendix of the final report.

In general, the field delineation on the site will begin at the property boundary or other convenient (i.e., easily surveyed) location. The wetland boundary will be approximated through visual observations and professional judgement exercised in the field. A transect will be established extending from within the wetland perpendicular to the approximated boundary and into the non-wetland area. A quadrant will be established on the lower (i.e., wetland) end of the transect and observations of vegetation, soils and hydrology will be made. These observations will document the presence of the vegetation soil, and hydrologic criteria necessary to define a wetland by both federal and Connecticut State criteria. A second quadrant will be established just upgradient of the estimated wetland boundary (in the estimated non-wetland) which should allow documentation of non-wetland conditions. A third quadrant will be established on the estimated boundary. Data from these quadrants will be used to refine the location of the boundary as needed.

Once the boundary has been determined in this way, it will be walked and flagged about every 50 feet using visual observations (concerning vegetation, soils, topography and hydrology) and professional judgement. Additional documentation transects will be established as described above when different cover types are encountered. A minimum of three documentation transects will be utilized on the site.

A map will be prepared by a surveyor; and the information obtained at transect locations will be transferred to data sheets.

Appropriate keys and text in identifying wetland plants and hydric soils will be used. These will include, but will not be limited to:

- Reed, Porter, 1988. National List of Plant Species That Occur in Wetlands; Northeast (Region I).

- Fernald, Linden, Gray's Manual of Botany.

- Tiner, Ralph W. Jr. 1988. Field Guide to Non-Tidal Wetland Identification, Maryland Department of Natural Resources, Annapolis, MD and USFWS, Newton Corner, MA.

- County Soil Conservation Service Publications (the specific publications will depend upon information acquired during the literature review and interviews with the County Soil Service).

The specific, step-by-step activities for the wetland delineation will include the following:

- A general reconnaissance survey of Area A will be completed.

- Vegetation cover types present within the study area will be identified.

- Starting points will be established for wetland boundary delineations.

- A transect perpendicular to site contour will be established.

- Federal wetlands will be located according to the Federal Manual based on vegetation, soils, and hydrologic criteria.

- State wetlands will be identified based on soil types as designated by the National Cooperative Soils Survey.

- Work will proceed by flagging the wetland boundaries about every 50 feet. As described above, the placement of these flags will be based upon information obtained from the quadrants, visual observations such as break in the slope of the land or changes in vegetation, and professional judgement.

- A minimum of three transects and at least one transect in each cover type will be established. Transect intervals should not exceed 0.5 miles as dictated by the 1987 Federal Manual.

Immediately after completion of field work, the field biologists will prepare documentation data forms which include: recording soils, vegetation, and hydrology data, and locating transects on a base map.

The optimum period to conduct the wetland delineation is during the growing season, late spring to summer.

5.3.4 Characterization of the Estuarine Environment of the Thames River

This section describes how the Thames River in the vicinity of the site will be characterized relative to ecological components (receptors) and the presence of contaminants in media to which the components may be exposed (surface water and sediment) and from which contaminants may migrate (ground water). It includes research on resident biota in the river and on the presence of rare, threatened, and endangered species; an assessment of the abundance of benthic invertebrates; and an assessment of the condition of resident bivalves and their body burden of contaminants.

These tasks will be accomplished by conducting a literature review of existing information on Thames River biota; a review of rare, threatened and endangered species; a quantitative benthic assessment; a bioaccumulation study using caged oysters; and chemical analysis of resident bivalves. Table 5-2 summarizes field sampling to be performed in the Thames River. These data products will be used in the exposure assessment and characterization of risk.

5.3.4.1 Review of Existing Thames River Literature

Available information on the estuarine environment of the Thames River and on some resident and migrating species was reviewed in Section 5.2.2.4 of this Work Plan. Additional information on the Thames River estuary will be sought via a computerized literature search and conversations with various regulatory agencies such as the CTDEP, USFWS, and shellfish wardens of neighboring cities and towns. Local colleges and universities that may be conducting oceanographic or marine biological research in the estuary will also be contacted.

5.3.4.2 Review of Rare, Threatened or Endangered Species

Research performed for the Draft EIS for proposed dredging for the Sea Wolf Project indicated that there were no rare, threatened or endangered species that inhabit the Thames River. (This information was reviewed in Section 5.2.2.4 of this Work Plan.) For this site characterization, this information will be reviewed and updated, if necessary, by contacting the CTDEP, Connecticut Natural Heritage Program, and USFWS. Natural histories of these species will be developed through literature searches and discussions with the previously mentioned agencies.

TABLE 5-2
THAMES RIVER FIELD SAMPLING PLAN

Sample Location	Proposed Depth	Rationale	Sample Designations	Sample Type		Analysis						
				Sediment (No.)	Water (No.)	VOC	SVOC	Inorganics	Pesticides	PCB	Quantitative Benthic Survey	Engineering
Sediments												
T1SD1-T1SD2	0-6"	One tidal excursion above Subase to measure upgradient quality along river transect.	T1SD1-T1SD2	● (2)			● (2)	● (2)	● (2)	● (2)	● (2)	● (2)
T2SD1-T2SD2	0-6"	One tidal excursion below Subase to measure sediment quality along river transect.	T2SD1-T2SD2	● (2)			● (2)	● (2)	● (2)	● (2)	● (2)	● (2)
T3SD1-T3SD4	0-6"	Along bulkhead at stormwater outfalls at DRMO, Lower Subase, and Goss Cove to measure any impacts from these sites.	T3SD1-T3SD4	● (4)		●[1] (1)	● (4)	● (4)	● (4)	● (4)	● (4)	● (4)
T4SD1-T4SD4	0-6"	Along pier line at stormwater outfalls from DRMO, Lower Subase, and Goss Cove to measure any offshore impacts from these sites.	T4SD1-T4SD4	● (4)			● (4)	● (4)	● (4)	● (4)	● (4)	● (4)
T5SD1-T5SD4	0-6"	At Subase to measure sediment quality along river transect.	T5SD1-T5SD4	● (4)			● (4)	● (4)	● (4)	● (4)	● (4)	● (4)
			Sediment Totals	16			16	16	16	16	16	16
Water												
6SW1	Surface bottom	Upgradient sample location.	6SW1S 6SW1B		● (2)	● (2)	● (2)	● (2)	● (2)			
T3SW1-T3SW3	Surface bottom	To measure impacts of stormwater and ground water discharge from sites.	T3SW1S-3S T3SW1B-3B		● (6)	● (6)	● (6)	● (6)	● (6)			
T3SW1A-T3SW1B	Surface bottom	To measure area of influence/dilution from DRMO outfall.	T3SW1AS-1BS T3SW1AB-1BB		● (4)	● (4)	● (2)	● (4)	● (4)			
8SW1	Surface bottom	Downgradient sample location.	8SW1S 8SW1B		● (2)	● (2)	● (2)	● (2)	● (2)			
2DSW13	Surface bottom	To measure impacts at outfall from Area A.	2DSW13S 2DSW13B		● (2)	● (2)	● (2)	● (2)	● (2)			
			Water Totals		16	16	14	16	16			
Ecological Sampling												
COY1-COY5	Water column	To assess potential uptake and exposure effects of water column contaminants from both surface or ground water discharges.	COY1-COY5	Oyster tissue (5) plus replicates (5) (10)		● (10)	● (10)	● (10)	● (10)	● (10)		
West side of Thames River	Sediment	To assess potential exposure effects of water column contaminants on Thames River and to assess whether contaminants may enter the food chain via this mechanism.	BV1-BV6	Tissue from bivalve species (6)			● (6)	● (6)	● (6)	● (6)		
East side of Thames River (between bulkhead and pier)	Sediment		MU1-MU3	Tissue from mussel species (3)			● (3)	● (3)	● (3)	● (3)		
1. Sample T3SD1			Totals	19		10	19	19	19	19		

5.3.4.3 Quantitative Benthic Assessment

The purpose of the quantitative benthic assessment is to measure species composition, numerical abundance, and general biological community structure on the bottom of the Thames River. We will use these data to estimate actual or potential ecological impact to bottom welling communities from surface water or ground water discharges associated with the Subase.

The stations for the quantitative benthic samples will occur along five transects as shown on Figure 5-3.

- **Transects 1 and 2:** These two transects will cross the river upstream and downstream of the base.

- **Transect 3:** This transect will be just offshore of the Subase bulkhead line and parallel to it.

- **Transect 4:** This transect will be parallel to the Subase bulkhead, but along the pier line.

- **Transect 5:** This transect will be parallel to the shoreline, but on the opposite side of the channel.

Transects 1 and 2 will include two stations: one near shore and one offshore of the edge of the channel. The field biologist will choose the exact sampling locations in the field to ensure that samples are collected from similar types of sediments across the transect. The upstream and downstream transects will be chosen to be approximately one tidal excursion above and below the Subase. Transect locations in Figure 5-3 represent approximately one tidal excursion above and below the base based on general knowledge of East Coast estuarine areas. This information will be checked with the CTDEP and others knowledgeable about the physical oceanographic characteristics of the Thames River estuary prior to sampling; Transects 1 and 2 will be relocated, if necessary. The samples along these transects will be taken in sediment types similar to sediments along the transect directly opposite the Lower Subase.

Transects 3, 4 and 5 will each include: one station opposite the surface water discharge near the DRMO, one station opposite the storm water discharge from Area A, one station opposite the Lower Subase, and one station just opposite Goss Cove.

Grab samples will be obtained at each of these 16 stations for analysis of benthic invertebrates; a sample from each station will be obtained for sediment grain size analysis, and analysis of total organic carbon (TOC), semi-volatile organic compounds, PCBs and pesticides, and metals. The sediment samples will be collected by using a clean Kynar-coated 0.04-m2 van Veen grab sample collector. The benthic samples will be sieved on a 0.5-mm mesh screen and preserved with 10 percent buffered formalin in the field, which will be exchanged for isopropyl alcohol in the laboratory. Samples will be sent to Cove Associates for biological analyses. Samples for TOC, sediment grain size, and chemical analysis will be stored at approximately 4°C until shipment to the analytical laboratory. At each station, we will measure salinity and oxygen at 1-meter intervals from surface to bottom with portable YSI meters.

Between each of the quantitative benthic stations along the transects and at randomly chosen stations between transect lines, we will take grab samples from the bottom sediments to make field assessments of the general sediment physical and biological conditions. A sediment grab will be sieved by using a 1-mm mesh sieve, and a qualitative description of the macrofauna will be conducted in the field. The 1-mm sieving may not be performed at every site, unless it consistently yields valuable information. Visual observations of sediment texture (mud, sand, gravel), depth of oxidation layer (aerobic/anaerobic interface) and surface characteristics (worm tubes, burrows, etc.) will be recorded for each sample. These observations will be used to assess the homogeneity of sediments between stations and transects.

The data analysis will include internal comparisons among upstream, opposite bank, and downstream stations with the stations taken along the bulkhead line and pier line of the Lower Base. We will also make external comparisons to studies previously carried out in the Thames River and to data in the scientific literature which address the nature of benthic communities in similar estuaries.

The parameters of comparison will include such observations as species richness (number of species), total invertebrate abundance, dominant species, and species evenness (as distribution of species among total abundance). We will make particular note of dominance by opportunistic species or depressed abundances within the invertebrate community.

5.3.4.4 Caged Oyster Study

The purpose of the caged oyster study is to assess potential uptake and exposure effects of water column contaminants (either from surface water or ground water discharges) on epibenthic biota of the Thames River. We will use these data to estimate actual or potential ecological impact to bottom dwelling communities from surface water or ground water discharges associated with the Subase.

Uptake of contaminants by caged oysters will be measured at five stations: approximately one tidal excursion upstream and downstream of the Subase and just offshore of the DRMO, Lower Subase, and Goss Cove. The study will employ the methods of Munns et al. (1991) for caged mussels at the Naval Construction Battalion Center in Davisville, Rhode Island.

This method uses non-indigenous oysters (*Crassostrea virginica)*, known to be uncontaminated as a surrogate species to provide exposure and effects information at stations just offshore. Oysters will be used as test organisms rather than mussels (the organisms traditionally used in this type of test), because oysters are more tolerant of variations in salinity. There is a salinity gradient with depth in the Thames River near the Subase and the use of oysters as test organisms will allow the cages to be placed in shallower, less saline water, if necessary. Approximately 100 oysters will be placed in moored and buoyed cages deployed at the approximate depth where ground water presumably discharges to the Thames River from the Subase. Replicate deployments will be made at each station for a 28-day period. At the end of the deployment period, the oysters will be shucked immediately and frozen. Samples will be delivered frozen to the analytical laboratory. An appropriate subsample, sufficient for analysis, will be analyzed for the full TCL and TAL parameters by CLP methods. Sampling holding times will conform to CLP protocols. The tissue samples will be analyzed for VOCs by a modified Method 8240. In place of the purge and trap method the tissue is first sonicated with a small amount of reagent water. The VOCs driven from the sample in this manner are then captured in a liquid nitrogen cold trap. From this point on, the analysis follows standard GC/MS methods. Sample handling is kept to a minimum with this method.

During the deployments, the cages will be observed weekly to assess the extent of fouling. If, in the opinion of the field biologist making these observations, the fouling is detrimental to the survival of or adequate feeding by the oysters, the cages will be retrieved, cleaned, and re-deployed.

5.3.4.5 Analysis Of Resident Bivalves

Resident bivalves will be analyzed to assess potential exposure effects of water column contaminants (either from surface water or ground water discharges) on the Thames River and to assess whether contaminants may potentially enter the food chain via this mechanism.

Tidal flats and subtidal areas are present along the shore of the Thames River opposite the Lower Base. We will collect resident bivalves from these areas for analysis of contaminants of concern. Likely species include Hard-Shell Clams (*Mercenaria mercenaria*), Oysters, or Soft-Shell Clams (*Mya arenaria).* In addition, we will sample the area between the bulkhead and pier line parallel to the lower base for bivalves. Likely species in this area may include mussels (*Mytilus edulis* or *Modiolus*).

Depending on the station depth and environmental conditions at a site, one of several collecting techniques will be employed to obtain bivalves from shellfish beds. Collection methods may include using a stainless steel skip dredge, using a stainless steel rake, and hand collecting. Polyethylene gloves will be worn when handling bivalves, and non-contaminating techniques will be used for all sample handling and processing.

Nine bivalve samples will be collected for chemical analysis. Two bivalve species will be collected from shellfish beds on the west side of the Thames River. Species collected will depend upon the areal distribution of bivalve species in these areas. One mussel species will be collected from the bulkhead and pier line. Three separate composites of each of these species (nine total) will be collected and analyzed for the full TAL and partial TCL parameters under CLP; the TCL parameters include SVOCs, PCBs and pesticides only.

5.4 Plan for Problem Formulation

The purpose of the Problem Formulation stage of an ecological risk assessment is to establish overall objectives and scope. This has already been accomplished to a large extent during previous work for Area A and in the process of preparing this Work Plan for both Area A and the Thames River. This section describes the components of the Problem Formulation that will be developed further and finalized during execution of the Work Plan.

5.4.1 Identification of Contaminants of Concern

This task will identify contaminants of concern relative to ecological components of the system for the Ecological Risk Assessment. The previous investigation performed for Area A provides a preliminary list of contaminants of concern identified at the site. This list will be amended depending on the results of the analyses conducted under this work plan. Factors that will be considered in identifying contaminants of concern include:

- Concentrations in sediments, surface waters, and ground water that may discharge to the Thames River.

- Concentrations of contaminants in Area A surface soil, sediments, surface water, and ground water.

- Frequency of occurrence in these media.

- Background levels and the extent to which contaminants exceed these levels.

- Bioavailability of the contaminants in soils (for Area A) and sediments (for both Area A and the Thames River). This will consider the site-specific factors (e.g., total organic carbon) that may affect bioavailability.

- Physical-chemical properties such as solubility, partitioning to lipids, and volatility that may affect the behavior, transport, and accumulation of the contaminant.

- Potential for bioaccumulation or bioconcentration.

- Potency of the chemical with regard to identified toxicological endpoints.

- The effects of the contaminant and the potential that these effects may be additive or synergistic with those associated with other contaminants.

Based on a review of existing information, there are a number of candidate contaminants of concern at the Subase. These include: selected volatile organic compounds (chlorinated and aromatic), semi-volatile organic compounds (in particular PAHs), pesticides (in particular DDT and its residues), PCBs, and metals.

5.4.2 Identification of Exposure Pathways

An exposure pathway describes the links between the sources of contaminants and the ecological components (receptors) that may be exposed.

Exposure pathways were identified for Area A in the previous assessment. Information on soil and benthic invertebrates and frog (and possibly fish) body burdens will be used to obtain additional information on these pathways.

For the Thames River, potential exposure pathways will be identified by considering the source locations, the media through which the contaminants may be transported, the potential for bioaccumulation, and the characteristics of the receptors. Aquatic animals and plants can come into contact with contaminants in different ways. Exposure routes can include direct contact with and uptake via sediment or water, ingestion of food, and incidental ingestion of sediment.

5.4.3 Identification of Ecological Components (Receptors)

Ecological components including species, faunal types, and communities will be selected for evaluation. Ecological components for Area A were identified in the previous ecological risk assessment. For the Thames River, the identification of potential receptors (species) will be based on literature review and field observations conducted during the site characterization.

The list of ecological components in the Thames River will include species of animals and plants associated with the estuarine environment of the Thames River as well as functional groups and communities. The list will include those species, groups, and communities which are likely to occur in the vicinity of the Subase or (in the absence of toxicological data on such species) are phylogenetically or tropically similar to species likely to occur. The candidate species, groups, and communities will represent a reasonable cross-section of the major functional and structural components of the ecosystem under study. Consideration will be given to the inclusion of species or groups that represent different trophic levels (e.g. saprophytes, herbivores, primary and secondary carnivores) and a variety of feeding types (detritivores, scavengers, filter feeders, active predators, forage fish).

The assessment will focus on selected ecological components. Selection will be based on relative abundance and ecological importance within the estuarine system, availability and quality of applicable toxicological literature, relative sensitivity to the contaminants of concern, trophic status, relative mobility, and local feeding ranges, ability to bioaccumulate contaminants of concern, economic importance or federal/state endangerment status, and any observed visible evidence of stress.

5.5 Plan for Exposure Assessment

5.5.1 Objectives And Overview

The purpose of this section is to describe the steps in the development of an exposure assessment. According to recent U.S. EPA Guidance (ECO Update, December 1991), an exposure assessment should quantify "the magnitude and type of actual and/or potential exposures of ecological receptors to site contaminants". The key elements include: quantification of contaminant release, characterization of receptors, and measurement or estimation of exposure point concentrations.

5.5.2 Quantification Of Release, Migration, And Fate

The purpose of this task will be to estimate current and future contaminant levels in affected media. These estimates will be used to estimate exposure point concentrations. For Area A, the estimates will be based upon previous and new data. Most of the estimates for the Thames River will be based upon data collected under this Work Plan.

The ecological risk assessment will rely upon direct measurements from completed or planned sampling and, in some cases, estimated concentrations from modeling. The direct measurements include results from the analysis of ground water, soil, surface water, sediment, and tissue samples. For Area A, the assessment will rely upon previously collected data combined with results of analyses performed under this Work Plan. Results of ground water, surface water, sediment, and tissue analyses will be used to estimate exposure point concentrations for the Thames River.

The assessment will include summaries of these data in relevant media. These summaries will include maps of contaminant distribution, tabulated summaries, or statistical summaries, as appropriate, to present a clear sense of the current distribution of contaminants by medium.

U.S. EPA guidance suggests that fate and transport models be used to assess future contaminant levels or to predict the movement of contaminants from the source or between media. The ecological risk assessment will use fate models to assess the concentration of contaminants in sediment pore water or wetland soils in Area A and sediment pore water in the Thames River. These models will include predictions based upon Equilibrium Partitioning in which total organic carbon controls the distribution of contaminants. The ecological risk assessment will also use fate models to estimate exposures due to contaminant discharge with ground water to the Thames River.

5.5.2.1 Estimating Exposure In Soils and Sediments From Organic Contaminants - Equilibrium Partitioning

With regard to chemicals in wetland soils or saturated soils and sediments, risk assessment is interested in the "available fraction" of the compounds and not only the bulk concentrations. In the case of non-polar organic compounds (e.g., PAHs and PCBs), this assessment will use the Equilibrium Partitioning (EP) method to estimate concentrations of compounds that may exist in soil moisture or pore water and to which invertebrates and plants may be exposed. The method takes into account the organic fraction of the soil, sediment or wetland environment. For Area A, the previous assessment based on this approach will be refined using additional contaminant concentration and total organic content data for wetland and upland soils and for pond and stream sediments.

The Equilibrium Partitioning (EP) method establishes relationships between non-ionic organic compounds present in the sediment, interstitial water, and biota. These relationships are then used to develop sediment or soil levels which would provide an adequate level of safety for aquatic or soil communities.

The EP method assumes an organic compound in sediment and interstitial pore water achieves equilibrium over a short period of time. This equilibrium is governed by the extent of sediment adsorption. It has been established through numerous studies that for non-ionic organic compounds, adsorption occurs mainly via organic carbon. This sorption process can be quantified for a particular compound based upon its individual water/organic carbon partition coefficient. This organic carbon based sorption model has been found to be valid for sediments containing at least 0.1 percent organic carbon.

Since, in general, the toxicity of a compound to soil or benthic invertebrates is correlated to the interstitial water or soil moisture concentration, the EP method assumes that sediment or soil criteria can be derived based upon pore water concentrations which have been shown to produce no effects in a variety of aquatic organisms (i.e., Ambient Water Quality Criteria). Thus by setting the equilibrium concentration equal to an appropriate Water Quality Criterion, a Sediment Quality Criterion (SQC) can be calculated which represents a sediment concentration whose predicted pore water concentration would not pose a risk to the majority of individuals in an aquatic community. This criterion can then be compared to existing concentrations to determine whether or not a risk is present.

This approach is valid only for non-ionic compounds. For ionic compounds or for inorganic elements, the EP approach is not valid. However, the approach may be valid for ionic compounds in their associated form (e.g., phenol below a pH of 9). This method is valid for any type of sediment which contains more than approximately 0.1 to 0.5 percent organic carbon. The method assumes that ingestion of sediment is not a significant pathway of exposure.

The EP method allows for the establishment of a sediment criterion based upon organic carbon normalized values. Only organic carbon and the sediment concentration(s) must be measured to compare the SQC to site-specific values and thereby evaluate possible risk.

The estimated pore water (or soil moisture) concentration will be used as the estimated exposure point concentrations for individual organic compounds, and theoretical organism (soil or sediment invertebrate) concentrations at assumed equilibrium will be calculated where field data are unavailable.

5.5.2.2 Estimating Exposure in Soils and Sediments from Inorganic Contaminants

Direct measurements of concentrations will be used to estimate exposures to inorganic contaminants in soil and sediments. These will be used on a location-by-location basis.

For Area A soils and sediments, inorganics with concentrations greater than background (as determined in a separate ongoing study) will be treated as contaminants of concern. Soil concentrations will be compared to available information on phytotoxicity and soil invertebrate toxicity data on a location-by-location basis. Sediment concentrations will be compared with toxicity benchmarks developed by Long and Morgan (1990).

Exposure of benthic organisms to inorganic contaminants in Thames River sediments will be assessed via comparisons with upstream and downstream concentrations, literature concentrations for the Thames River estuary in particular and urban estuaries in general, and Long and Morgan data.

5.5.2.3 Estimating Exposures in Marine Systems

One major objective of the ecological risk assessment is to assess the potential links between contaminants in the sites bordering the Thames River (Goss Cove landfill, Lower Subase, and DRMO), contaminants carried from Area A in surface water, and the sediment, surface water and biota in the river. The approach of this assessment is to attempt to provide answers to three basic questions:

- What are the transport mechanisms operating between these sites and their associated near-shore and estuarine environments?

- What are the potential loadings of contaminants from these sites to the near-shore and estuarine environments?

- What is the ecological fate of these loadings in the Thames River?

The transport of contaminants into the river will be assessed with the following data: stream flow, surface and ground water quality from the current sampling program, and estimates of ground water flow. These are the primary physical linkages between the sites and the estuarine environment of the river.

Ranges of estimates of the potential mass of materials which reach the shores of the river from each of the sites will be calculated. The assessment will also address: the portioning of contaminants upon entering the river from the sites, biological uptake and degradation, the potential effect of tidal dilution and advection from the near shore area, and sedimentation. The partitioning estimates will rely upon equilibrium partitioning calculations. The likelihood of biological uptake or degradation within the estuarine environment will be assessed based on literature values for and observed body burdens in Thames River organisms, and measured concentrations in transplanted caged oysters. The probability of sedimentation within the river will also be based on literature estimates of sedimentation in the Thames River and measurements of contaminant concentrations in sediment at the outlets of the Area A watercourses. The potential for tidal dilution and subsequent transport from near-shore environments will be based upon calculations.

The assessment will describe the likely fate of contaminants entering the near-shore environments from the sites based on this analysis. Estimates of the range of incremental increases in contaminant concentrations in river water and sediment due to the sites will be made.

5.5.3 Characterization of Receptors

As U.S. EPA guidance indicates, most sites contain many species, populations, and communities, and evaluating risk to each is practically impossible. Therefore, ecological risk assessment focuses upon a limited number of receptors. The selection of receptors is part of the problem formulation (Section 5.4).

For Area A, the ecological receptors were characterized in the previous risk assessment. This section addresses the characterization of receptors for the Thames River.

The characterization of receptors will include information on the species' feeding habits, life histories, habitat preferences, and other attributes which could affect their exposure or sensitivity to contaminants. The characterization of receptors (species) for this site will derive from the literature review which will include a review of existing studies (Section 5.3.4.1) and results of surveys and field observations described in Section 5.3.4.

Categories of receptors are expected to include the following:

- mammals and birds that take their food from the Thames River
- benthic invertebrates
- fish

For each receptor, the assessment will include a characterization in the form of a species profile. These profiles will be text descriptions of the relevant ecological and physiological characteristics and taxonomic relationships of the receptors. The profiles will include but not be limited to descriptions of: trophic status, feeding type, food preferences, ingestion rates, range, prey, predators, migratory habits, breeding habits, likely habitats, population estimates, reproductive strategies, substrate and habitat preferences, and life history. The profiles will also include any particular vulnerabilities or status of the species as rare or endangered.

5.5.4 Estimation of Exposure Point Concentrations

According to U.S. EPA guidance, exposure point concentrations are estimates of the concentration of contaminants in the media to which the receptors are exposed. This is either measured in the environmental medium or estimated using assumptions and/or fate and transport modeling. The estimates of exposure point concentrations in each medium will generally follow U.S. EPA Guidance (Section 6.5, "Risk Assessment Guidance For Superfund Volume I, Human Health Evaluation Manual (Part A)", U.S. EPA/540/1-89/002). This guidance indicates that: direct use of monitoring data is normally applicable where exposure involves direct contact with the monitored medium as in the case of soils; modeling is appropriate when exposure points are spatially separate from monitoring points, where spatial distribution of data is lacking, or where monitoring data are restricted by the limit of quantitation; and when the objective is to provide a conservative estimate of the average concentration contacted at the exposure point over a period of exposure.

The estimated exposure point concentrations will be based upon field data or, where such data are unavailable, upon modeled concentrations. The onsite and offsite data bases are expected to be sufficient for this purpose. However, as indicated in Section 5.5.2, appropriate analytical models for deriving exposure point concentrations will be used in several cases. In Area A, new and previously existing data will be used to estimate exposure point concentrations.

Estimates of exposure point concentrations will either be discrete measurements assessed at a sampling station or will be a calculated statistic. An example of the former would include an assessment of exposure from soil or sediment. Each discrete measurement would be considered an exposure point for the purpose of assessing risk at that point. In other media, such as the water column or ground water, an appropriate statistic such as the mean or maximum value will be used. This will vary with exposure pathway and medium.

Exposure point concentrations will be presented in tables which include the pathway, receptor, estimate of exposure point concentrations, and comments summarizing the source or derivation of the estimate.

5.6 Plan for Ecological Effects Assessment

5.6.1 Overview

Ultimately, the ecological risk characterization will be used to identify, compile, and evaluate the data necessary to relate exposure point concentrations to effects (appropriate biological endpoints). This requires the development of toxicological information related to the selected biological endpoints. Such information will be obtained from the literature on the effects of site-related contaminants. Additional information on ecological effects will be drawn from site-specific field observations and toxicity testing.

For the terrestrial and freshwater ecosystem of Area A, much of this information was developed during the previous ecological risk assessment. Additional information for receptors in this area will be developed only if contaminants are identified that were not detected there previously. Information on the toxicological effects of contaminants of concern will be developed for species inhabiting the estuarine environment of the Thames River.

This effects assessment will identify the range of toxic endpoints and discuss potential biological effects of site-related contaminants within various concentration ranges. The endpoints may include: lethality, reproductive impairment, behavioral modifications, or various sub-lethal toxic effects. Endpoints may also include secondary effects such as loss of habitat. This analysis is used to select toxic endpoints for eventual risk characterization.

5.6.2 Review of Ecotoxicological Literature

Much of the information for this part of the analysis will be drawn from the scientific literature and is available from previous work, particularly for Area A. Computerized literature searches and reviews of the recent primary literature will be used to supplement information that is currently readily available for the contaminants of concern. With regard to effects on aquatic organisms, a search will be made for recent data in U.S. EPA's AQUIRE data base. Recent publications in the Society of Environmental Toxicology and Chemistry (SETAC) journal and papers presented at recent SETAC symposia are helpful for identifying the most recent research.

The following data bases are used to obtain information on wildlife, fish and benthic invertebrates: Bios Previews; Life Sciences Collection; Zoological Record Online; Enviroline; Pollution Abstracts; Oceanic Abstracts; and CAB Abstracts. These are available through the DIALOG Information Services. The TOXNET (TOXicological NETwork), AQUIRE, and IRIS

(Integrated Risk Information System) data bases are accessed via the National Library of Medicine's MEDLARS system.

The output from the searches will be stored on file, reviewed at the end of the search, and the relevant material will then be printed. The material will be incorporated into the appropriate files of biological, chemical, and toxicological data, endpoints, or results of acute and chronic studies in EXCEL data bases for use in the final report.

5.6.3 Use of Terrestrial, Aquatic, and Wetland Field Studies

Field observations will be used to help characterize conditions at the site. Such direct observations may identify ecological effects such as reduced species diversity, presence of opportunistic species, or pathologies. This information will be evaluated with regard to the potential effects of contaminants of concern.

5.7 Plan for Risk Characterization

The risk characterization is a synthesis process; for this ecological risk assessment, the risk characterization will integrate previous data with information gathered under this Work Plan. Since the ecological risk assessment will take a "weight of evidence" approach, the different types of information (contaminant distribution information, toxicity information, field data, etc.) will be presented and professional judgement will be used to assess its importance in the risk analysis.

5.7.1 Potential Habitat Modification

Ecological effects can result from physical modifications of the habitat as well as from stress due to contaminants. For example, dredging of the Thames River has altered the habitat of benthic organisms. Therefore, the assessment of potential effects of the Subase on the Thames River must take the effects of habitat modifications into account.

Potential risks associated with habitat modification will be evaluated in the risk characterization. These may be related to physical alterations of soil, sediment, or freshwater flow as well as other alterations which would impact the quality of the habitat.

5.7.2 Risks Due to Toxic Effects of Contaminants

A qualitative and quantitative assessment of risks to ecological receptors will be performed with regard to toxic effects. This analysis will use information generated from the Exposure and Ecological Effects Assessments and will rely upon the Toxicity Quotient approach as well as on direct observations of conditions in the field to provide an overall weight of evidence concerning the nature of risks.

The Quotient approach, which was also used in the previous ecological risk assessment of Area A, involves comparing an exposure concentration to an effects level such as a No Observed Adverse Effect Level. Quotient values that exceed "1" (exposure/effects level) are considered to be indicative of potential risk. Such values do not necessarily indicate that an effect will occur but only that a lower threshold has been exceeded. Because the NOAEL values typically have uncertainty (safety) factors of 10 built into them, evaluation of the significance of the Toxicity Quotients will be as follows:

- Toxicity Quotient Exceeds "1" but less than "10" - some small potential for environmental effects.

- Toxicity Quotient Exceeds "10" - significant potential that greater exposures could result in effects based on experimental evidence.

- Toxicity Quotient Exceeds "100" - effects may be expected since this represents an exposure level at which effects have been observed in other species.

Information provided by the Toxicity Quotient will be compared to field observations and measurements regarding presence and abundance or organisms and their body burdens of contaminants to evaluate whether trends in the data implicate contaminants in soil, sediment, or surface water as the cause of observed ecological stress.

Note that this risk characterization method provides some insight into general effects upon animals in the local population. However, it does not indicate if population-level effects will occur. Such an assessment requires careful consideration of the local factors affecting populations. If effects are judged to be insignificant at the average individual level, they are probably insignificant at the population level. However, if risks are present at the individual level, they may or may not be important at the population level.

5.7.3 Presentation of Risk

Comparisons will be made between analytical data for sediments and water and published or estimated water quality criteria and sediment quality criteria or reference values. In the case of water quality criteria, the U.S. EPA and Connecticut published values will be used.

In addition, contaminant concentration in sediments will be compared to reference values within the freshwater and marine systems as well as to the general reference values reported in Long and Morgan (1990).

For example, contaminant concentrations in sediments will be compared to National Oceanographic and Atmospheric Association (NOAA) sediment benchmarks and U.S. EPA sediment criteria. For non-polar organic compounds for which no EPA sediment criteria are available, the Equilibrium Partitioning approach will be used to calculate sediment based on EPA and/or Connecticut water quality criteria. Contaminant concentrations in shellfish will be compared to data from the national Status and Trends Program. Biological composition of the infauna and epifauna will be compared to data in the literature on similar habitats in the Thames River and Long Island Sound. For some parameters, quantitation limits are below these biological effects levels. Any such limitations of the analytical data will be discussed in the uncertainty section of the ecological risk assessment.

6.0 PRELIMINARY IDENTIFICATION OF REMEDIAL ACTION ALTERNATIVES

Potential ARAR/TBC values for the Step II sites are identified and evaluated in detail in the Phase I RI. The sections below identify potentially significant ARARs at each site, include tables containing chemical-specific ARAR/TBC values for constituents of concern identified as significant at any of the sites, summarize risk assessments performed as part of the Phase I RI, and identify preliminary remedial action objectives and remedial alternative process options. Presented in Tables 6-1 through 6-4 are chemical-specific ARAR/TBC values for chemicals of concern at the various sites. Each of the following subsections specifically identify chemicals detected above ARAR/TBC values at the site being described. The Phase II data will be evaluated using the most recent ARAR/TBC data. This process is included to ensure that appropriate data requirements are specified in this Work Plan to complete the Phase II RI/FS.

Preliminary risk-based remediation target levels are also included. These were developed during the preparation of the Feasibility Study for Area A, DRMO and the Lower Subase, which is currently on hold pending completion of the Phase II RI. Backup information for the risk-based levels is included in Appendix D. These target levels are preliminary and are being presented here solely for the purpose of scoping the field investigations. Remedial action objectives will be developed in the future during the FS.

Presented in Table 6-5 and arranged by treatment technologies is a listing of parameters that could potentially be required to evaluate each treatment technology. The table indicates whether or not a parameter is included in the scope of work for this investigation. Comments are provided regarding the need for testing or rationale for not testing a specific parameter.

6.1 Step II Investigations

6.1.1 Rubble Fill at Bunker A-86

6.1.1.1 Potential ARARs

The only chemical-specific ARAR/TBC value that was exceeded during the Step I investigation performed at this site was the TBC value for soils of 100 ppb for methoxychlor. This TBC standard is based on CTDEP guidance, and there was only one soil sample exceeding this standard at 370 ppb. Potentially significant chemical-specific ARARs applicable to this site include federal and state drinking (U.S. EPA 1991; CTDOHS 1992) and surface water quality standards and criteria (U.S. EPA 1986; CTDEP 1992).

No significant location-specific ARARs were identified that are applicable to this site.

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site.

TABLE 6-1
FEDERAL DRINKING WATER STANDARDS AND HEALTH ADVISORIES

	Standards (ARAR)				Health Advisories (TBC)								
					10-kg Child			70-kg Adult					
Chemicals	Status Reg.*	MCLG (mg/l)	MCL (mg/l)	Status HA*	One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	LifetiME (mg/l)	mgl at 10^{-4} Cancer Risk	Cancer Group
Organics													
Benzene	F	zero	0.005	F	0.2	0.2	-	-	-	-	-	0.1	A
Bis(2-ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-	-	-	-	-
Dichlorobenzene p-	F	0.075	0.075	F	10	10	10	40	0.1	4	0.075	-	C
Dichloroethane (1,2-)	F	zero	0.005	F	0.7	0.7	0.7	2.6	-	-	-	0.04	B2
Dichlorethylene (1,1-)	F	0.007	0.007	F	2	1	1	4	0.009	0.4	0.007	-	C
Dichlorethylene (cis-1,2-)	F	0.07	0.07	F	4	3	3	11	0.01	0.4	0.07	-	D
Fluorene (PAH)	-	-	-	-	-	-	-	-	0.04	-	-	-	D
Naphthalene	-	-	-	F	0.5	0.5	0.4	1	0.004	0.1	0.02	-	D
Phenanthrene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated biphenyls (PCBs)	F	zero	0.0005	P	-	-	-	-	-	-	-	0.0005	B2
Tetrachloroethylene	F	zero	0.005	F	2	2	1	5	0.01	0.6	-	0.07	-
Toluene	F	1	1	F	20	2	2	7	0.2	7	1	-	D
Trichloroethylene	F	zero	0.005	F	-	-	-	-	-	0.3	-	0.3	B2
Vinyl Chloride	F	zero	0.002	F	3	3	0.01	0.05	-	-	-	0.0015	A
Inorganics													
Aluminum	L	-	-	D	-	-	-	-	-	-	-	-	-
Antimony	F	0.006	0.006	F	0.015	0.015	0.015	0.015	0.0004	0.015	0.003	-	D
Arsenic	*	-	0.05	D	-	-	-	-	-	-	-	0.002	A
Barium	F	2	2	F	-	-	-	-	0.07	2	2	-	D
Cadmium	F	0.005	0.005	F	0.04	0.04	0.005	0.02	0.0005	0.02	0.005	-	D
Chromium (total)	F	0.1	0.1	F	1	1	0.2	0.8	0.005	0.2	0.1	-	D
Copper	F	1.3	TT**	-	-	-	-	-	-	-	-	-	D
Cyanide	F	0.2	0.2	F	0.2	0.2	0.2	0.8	0.022	0.8	0.2	-	D
Lead (at tap)	F	zero	TT**	-	-	-	-	-	-	-	-	-	B2
Mercury (inorganic)	F	0.002	0.002	F	-	-	-	0.002	0.0003	0.01	0.002	-	D

TABLE 6-1 (Continued)
FEDERAL DRINKING WATER STANDARDS AND HEALTH ADVISORIES

Chemicals	Standards (ARAR)			Status HA*	Health Advisories (TBC)								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.*	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	LifetiME (mg/l)	mgl at 10^{-4} Cancer Risk	
Selenium	F	0.05	0.05	-	-	-	-	-	0.005	-	-	-	-
Silver	-	-	-	D	0.2	0.2	0.2	0.2	0.005	0.2	0.1	-	D
Sodium	-	-	-	D	-	-	-	-	-	20***	-	-	-
Thallium	F	0.0005	0.002	F	0.007	0.007	0.007	0.02	0.00007	0.002	0.0004	-	-
Vanadium	L	-	-	D	0.08	0.08	0.03	0.11	0.003	0.11	0.02	-	D
Zinc	L	-	-	F	6	6	3	12	0.3	11	2	.	D
Radionuclides													
Beta particle and photon activity (formerly man-made radionuclides)	F	zero	4mrem	-	-	-	-	-	-	-	-	4 mrem/y	A
Gross alpha particle activity	F	zero	15 pCi/L	-	-	-	-	-	-	-	-	-	A

N tes: Phenanthrene - not proposed.
- * Under review.
- ** Copper - action level 1.3 mg/L
  Lead - action level 0.015 mg/L
- *** Guidance

D means draft
F means final

TABLE 6-2 FEDERAL SECONDARY MAXIMUM CONTAMINANT LEVELS (TBC)		
Chemicals	**Status**	**SMCLs (mg/l)**
Aluminum	F	0.05 to 0.2
Copper	F	1
Iron	F	0.3
Manganese	F	0.05
Silver	F	0.10
Zinc	F	5
Status Codes: F - final		

TABLE 6-3 STATE OF CONNECTICUT DRINKING WATER STANDARDS AND ACTION LEVELS		
Chemicals	**Standard (ARAR) Maximum Contaminant Level (mg/l)**	**Action Level (TBC) (mg/l)**
Arsenic	0.05	
Barium	1.0	
Cadmium	0.010	
Chromium	0.05	
Lead	0.05	
Mercury	0.002	
Selenium	0.01	
Silver	0.05	
Copper	1.0	
Sodium	28	
Gross Alpha	15 pCi/l	
Gross Beta	50 pCi/l	
Benzene	0.005	0.001
p-dichlorobenzene	0.075	
1,2-dichloroethane (EDC)	0.001	
1,1-dichloroethylene	0.007	
cis-1,2-dichloroethylene		
trans-1,2-dichloroethylene		
Tetrachloroethylene	0.005	
Toluene	1.0	
Trichloroethylene	0.005	
Vinyl Chloride	0.002	
Methoxychlor	0.370	
PCB	0.001	
Note: CTDOHS MCL are also TBC values for soil per CTDEP guidance.		

TABLE 6-4
CTDEP NUMERICAL WATER QUALITY CRITERIA
FOR CHEMICAL CONSTITUENTS IN SURFACE WATER (ARAR)
(concentrations in ug/l)

Compound	Aquatic Life Criteria[1]				Human Health Criteria[2]		
	Freshwater		Saltwater		Consumption Of		
	Acute[3]	Chronic[4]	Acute	Chronic	Organisms Only	Water and Organisms	Human Health Designation
Antimony	---	---	---	---	4300[7]	14[7]	TT
Arsenic (Tri)	360[7]	190[7]	69[7]	36[7]	0.14[7]	0.018[7]	A
Benzene	---	---	---	---	71	1.2	A
Cadmium	1.80[7,8]	0.660[7,8]	43[7]	9.3[7]	170[7]	16[7]	TT
1,2,4-Trichlorobenzene	---	---	---	---	---	---	TT-HB
1,2-Dichloroethane	---	---	---	---	99	0.38	C
Chromium (tri)	980[7,8]	120[7,8]	---	---	670,000[7]	33,000[7]	TT
Chromium (hex)	16[7]	11[7]	1100[7]	50[7]	3,400[7]	170[7]	TT
Copper	14.3 [7,9,10]	4.8 [7,9,11]	2.9[7]	2.9[7]	---	---	---
DDT	0.55	0.001	0.065	0.001	0.00059	0.00059	C-HB
DDD	---	---	---	---	0.00084	0.00083	C-HB
DDE	---	---	---	---	0.00059	0.00059	C-HB
1,4-Dichlorobenzene	---	---	---	---	2,600	400	TT-HB
1,1-Dichloroethylene	---	---	---	---	3.2	0.057	C
1,2-Trans-Dichloroethylene	---	---	---	---	---	---	TT
Lead	34[7,8]	1.30[7,8]	220[7]	8.5[7]	---	50[7]	TT
Mercury	2.40[8]	0.12[8,13]	2.1[8]	0.025[8,13]	0.15[7]	0.14[7]	TT

TABLE 6-4 (Continued)
CTDEP NUMERICAL WATER QUALITY CRITERIA
FOR CHEMICAL CONSTITUENTS IN SURFACE WATER (ARAR)
(concentrations in ug/l)

Compound	Aquatic Life Criteria[1]				Human Health Criteria[2]		
	Freshwater		Saltwater		Consumption Of		
	Acute[3]	Chronic[4]	Acute	Chronic	Organisms Only	Water and Organisms	Human Health Designation
Naphthalene	---	---	---	---	---	---	---
Arochlor 1260	---	0.014	---	0.03	0.000045	0.000044	C-HB
Fluorene	---	---	---	---	14,000	1,300	C-HB
Phenanthrene	---	---	---	---	0.031	0.0028	C-HB
Selenium	20[7]	5[7]	300[7]	71[7]	6,800[7]	100[7]	TT
Silver	1.20[7,8]	---	2.3[7]	---	65,000[7]	105[7]	TT
Tetrachloroethylene	---	---	---	---	8.85	0.8	TT
Thallium	---	---	---	---	6.3[7]	1.7[7]	TT
Toluene	---	---	---	---	200,000	6,800	TT
Trichloroethylene	---	---	---	---	81	2.7	C
Vinyl Chloride	---	---	---	---	525	2	C
Zinc	35.3[7,9,10]	12.3[7,9,11]	95[7]	86[7]	---	---	TT
U.S. EPA Water Quality Criteria for Constituents Not Listed Above (ARAR)							
Iron	---	1000	---	---	---	300	---
Manganese	---	2	---	---	100	50	---

TABLE 6-4 (Continued)
CTDEP NUMERICAL WATER QUALITY CRITERIA FOR CHEMICAL CONSTITUENTS IN SURFACE WATER (ARAR)
(concentrations in ug/l)

1. Criteria derived as described in "Appendix B - Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and Its Uses" (45 FR 79341, November 28, 1980) as amended by "Summary of Revisions to Guidelines for Deriving Numerical National Criteria for the Protection of Aquatic Organisms and Their Uses" (50 FR 30792, July 29, 1985).
2. Criteria derived as described in "Appendix C - Guidelines and Methodology Used in the Preparation of Health Effects Assessment Chapters of the Consent Decree Water Criteria Documents" (45 FR79357, November 28, 1980). Assumptions used in the derivation of criteria include: 1 x 10^{-6} risk level, 70 kilogram adult, lifetime exposure, 6.5 grams/day of seafood consumed or 6.5 grams/day seafood plus two liters/day of drinking water consumed.
3. Biological integrity is impaired by an exposure of one hour or longer to a concentration which exceeds the acute criteria more frequently than once every three years on average.
4. Biological integrity is impaired when the four-day average concentration exceeds the chronic criteria more frequently than once every three years on average.
5. The Commission will consider the following human health designations in allocating zones of influence for point source discharges:

   A - class A carcinogen (known human carcinogen)
   TT - threshold Toxicant, not carcinogenic
   C - carcinogenic (probably or possible carcinogen)
   HB - high potential to bioaccumulate or bioconcentrate

6. Criteria for freshwater derived assuming pH 7.0; criteria for marine and estuarine waters derived using pH 8.0. Criteria may be adjusted to account for seasonal variation in temperature as indicated below. Values are expressed in mg/l.

Acute Toxicity

	Temperature °C						
	0	5	10	15	20	25	30
Freshwater (general)	23.1	21.4	20.6	19.8	18.9	13.2	9.9
Freshwater (Salmon spawning)	23.1	21.4	20.6	19.8	18.9	13.2	9.9
Estuarine (20 mg/kg salinity)	29.0	20.0	14.0	9.8	6.7	4.8	3.3
Marine (30 mg/kg salinity)	31.0	21.0	15.0	10.0	7.3	5.0	3.5

TABLE 6-4 (Continued)
CTDEP NUMERICAL WATER QUALITY CRITERIA
FOR CHEMICAL CONSTITUENTS IN SURFACE WATER (ARAR)
(concentrations in ug/l)

Chronic Toxicity

	Temperature °C						
	0	5	10	15	20	25	30
Freshwater (general)	2.06	1.98	1.81	1.81	1.73	1.24	0.82
Freshwater (Salmon spawning)	2.06	1.98	1.81	1.81	1.24	0.86	0.60
Estuarine (20 mg/kg salinity)	4.40	3.00	2.10	1.50	1.00	0.72	0.31
Marine (30 mg/kg salinity)	4.70	3.10	2.20	1.60	1.10	0.75	0.53

7. Criterion applies to the dissolved fractions.
8. Criterion value derived assuming a statewide average hardness of 50 mg/l as $CaCO_3$.
9. Criterion derived as described in Technical Support Document for Derivation of Numerical Criteria for the Heavy Metals Copper and Zinc. (Bureau of Water Management, Connecticut DEP).
10. WQC for consumption of water and organisms are also classified as TBC for consumption at ground water if no MCL, health advisories, or action levels are available.

TABLE 6-5
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
					General				
Microbial Degradation									
Soils/ sludges	**Physical:** Moisture content	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives biological treatment does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	Temperature								
	Oxygen availability								
	Chemical: pH	●	●	●	●	●	●	●	
	Total organic carbon	●	●	●	●	●	●	●	
	Redox potential								
	C:N:P ratio								
	Heavy metals	●	●	●	●	●	●	●	
	Chlorides/inorganic salts								
	Biological: Soil biometry								
	Respirometry								
	Microbial identification and enumeration								
	Microbial toxicity/ growth inhibition								
Liquids	**Chemical:** pH	●	●	●	●	●	●	●	
	Dissolved oxygen								
	Chemical oxygen demand	●	●	●	●	●	●	●	
	Biological: Biological oxygen demand	●	●	●	●	●	●	●	
	Respirometry								

● indicates data requirement will be collected for site indicated

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Microbial identification and enumeration								
Soils/ sludges	**Physical:** Type, size of debris								
	Dioxins/furans, radionuclides, asbestos			•		•	•		
				Extraction					
-Aqueous *-Solvent* *-Critical fluid* *-Air/steam*									
Soils/ sludges	**Physical:** Particle size distribution	•	•	•	•	•	•	•	To determine volume reduction potential, pretreatment needs, solid/liquid separability.
	Clay content	•	•	•	•	•	•	•	To determine adsorption characteristics of soil.
	Moisture content	•	•	•	•	•	•	•	To determine conductivity of air through soil.
	Chemical: Organics	•	•	•	•	•	•	•	To determine concentration of target or interfering constituents, pretreatment needs, extraction medium.
	Metals (total)	•	•	•	•	•	•	•	To determine concentration of target or interfering constituents, pretreatment needs, extraction medium.
	Metals (leachable)	•	•	•	•	•	•	•	To determine mobility of target constituents, post treatment needs.
	Contaminant characteristics: • Vapor pressure • Solubility • Henry's Law constant • Partition coefficient • Boiling point • Specific gravity	•	•	•	•	•	•	•	To aid in selection of extraction medium.
	Total organic carbon, humic acid	•	•	•	•	•	•	•	To determine presence of organic matter, adsorption characteristics of soil.
	Cation exchange capacity	•	•	•	•	•	•	•	To determine adsorption characteristics of soil.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Chemical oxygen demand								This parameter will be measured on water from the ponds and ground water to evaluate the potential for fouling. No additional measurements appear to be necessary.
	pH	•	•	•	•	•	•	•	To determine pretreatment needs, extraction medium.
	Cyanides, sulfides, fluorides	•	•	•	•	•	•	•	To determine potential for generating toxic fumes at low pH. Cyanides only.
	Biological: Biological oxygen demand								This parameter will be measured on water from the ponds and ground water to evaluate the potential for fouling. No additional measurements appear to be necessary.
					Chemical Dehalogenation				
Soils/ sludges	**Physical:** Moisture content	•	•	•	•	•	•	•	Based upon initial screening of process options and scoping of alternatives, chemical dehalogenation does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	Particle-size distribution	•	•	•	•	•	•	•	
	Chemical: Halogenated organics	•	•	•	•	•	•	•	
	Metals	•	•	•	•	•	•	•	
	pH/base absorption capacity								
Liquids	**Chemical:** Halogenated organics								
					Oxidation/Reduction				
Liquids	**Physical:** Total suspended solids	•	•	•	•	•	•	•	To determine the need for slurrying to aid mixing.
	Chemical: Chemical oxygen demand	•	•	•	•	•	•	•	To determine the presence of oxidizable organic matter, reagent requirements.
	Metals (Cr^{+3}, Hg, Pb, As)	•	•	•	•	•	•	•	To determine the presence of constituents that could be oxidized to more toxic or mobile forms.
	pH	•	•	•	•	•	•	•	To determine potential chemical interferences.
					Flocculation/Sedimentation				
Liquids	**Physical:** Total suspended solids	•						•	To determine reagent requirements.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Specific gravity of suspended solids								The solids being removed from water waste streams consist of soils and sediments. The specific gravity of soils and sediments is being determined on bulk samples.
	Viscosity of liquid								The only liquids potentially requiring treatment is water with low levels of contamination. The viscosity of water is known.
	Chemical: pH	●	●	●	●	●	●	●	To aid in selection of flocculating agent.
	Oil and grease	●	●	●	●	●	●	●	To determine need for emulsifying agents, oil/water separation.
Carbon Adsorption									
Liquids	**Physical:** Total suspended solids								To determine need for pretreatment to prevent clogging.
	Chemical: Organics								To determine concentration of target constituents, carbon loading rate.
	Oil and grease								To determine need for pretreatment to prevent clogging.
	Biological: Microbial plate count								BOD is being measured, which can be used to determine fouling potential.
Ion Exchange									
Liquids	**Physical:** Total suspended solids	●	●	●	●	●	●	●	To determine need for pretreatment to prevent clogging.
	Chemical: Inorganic cations and anions, phenols	●	●	●	●	●	●	●	To determine concentration of target constituents.
	Oil and grease	●	●	●	●	●	●	●	To determine need for pretreatment to prevent clogging.

TABLE 6-5 (C ntinued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Reverse Osmosis								
Liquids	**Physical:**								Based upon initial screening of process options and scoping of alternatives reverse osmosis does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	Total suspended solids	•	•	•	•	•	•	•	
	Chemical:								
	Metal ions, organics	•	•	•	•	•	•	•	
	pH	•	•	•	•	•	•	•	
	Residual chlorine								
	Biological:								
	Microbial plate count								
	Liquid/Liquid Extraction								
Liquids	**Physical:**								Based upon initial screening of process options and scoping of alternatives liquid/liquid extraction does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	Solubility, specific gravity								
	Chemical:								
	Contaminant characteristics: • Solubility • Partition coefficient • Boiling point								
	Oil/Water Separation								
Liquids	**Physical:**								Free phase oil is not expected to be present. If free phase oil is detected (possibly at Lower Subase) the need for testing these parameters should be re-evaluated.
	Viscosity								
	Specific gravity								
	Settleable solids								
	Temperature	•	•	•	•	•	•	•	To determine rise rate of oil globules.
	Chemical:								
	Oil and grease	•	•	•	•	•	•	•	To determine concentration of target constituents.
	Organics	•	•	•	•	•	•	•	To determine need for post treatment.
	Air/Steam Stripping								
Liquids	**Chemical:**								
	Hardness	•	•	•	•	•	•	•	To determine potential for scale formation.
	Volatile organic compounds	•				•		•	To determine concentration of target constituents.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Contaminant Characteristics: • Solubility • Vapor pressure • Henry's Law constant • Boiling point • Mass transfer coefficient	•	•	•	•	•	•	•	To determine strippability of contaminants, size of units, and need for posttreatment. To determine stripping factor. To determine packing height.
	Chemical oxygen demand	•	•	•	•	•	•	•	To determine fouling potential.
	Biological: Biological oxygen demand	•	•	•	•	•	•	•	To determine fouling potential.
					Filtration				
Liquids	**Physical:** Total suspended solids	•	•	•	•	•	•	•	To determine need for pretreatment to prevent clogging.
					Neutralization				
Liquids	**Chemical:** pH	•	•	•	•	•	•	•	To determine reagent requirement.
	Metals	•	•	•	•	•	•	•	To determine need for post treatment.
	Acidity/alkalinity								pH is being measured.
	Cyanides, sulfides, fluorides	•	•	•	•	•	•	•	To determine potential for generating toxic fumes at low pH (cyanides only).
					Precipitation				
Liquids	**Chemical:** Metals	•	•	•	•	•	•	•	To determine concentration of target constituents, reagent requirements.
	pH	•	•	•	•	•	•	•	To determine solubility of metal precipitates, reagent requirements.
	Organics, cyanides	•	•	•	•	•	•	•	To determine concentration of interfering constituents, reagent requirements.
					Oxidation (Alkaline Chlorination)				
Liquids	**Chemical:** Cyanides	•	•	•	•	•	•	•	Based upon initial screening of process options and scoping of alternatives oxidation does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	pH	•	•	•	•	•	•	•	
	Organics	•	•	•	•	•	•	•	
	Redox potential				•	•	•		

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
					Reduction				
Liquids	**Chemical:** Metals (Cr^{+6}, Hg, Pb)	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives reduction does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
					Hydrolysis				
Liquids	**Chemical:** Organics	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives hydrolysis does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	pH	●	●	●	●	●	●	●	
					Stabilization/Solidification				
Soils/ sludges	**Physical:** Description of materials	●	●	●	●	●	●	●	To determine waste handling methods (e.g. crusher, shredder, removal equipment).
	Particle-size analysis	●	●	●	●	●	●	●	To determine surface area available for binder contact and leaching.
	Moisture content	●	●	●	●	●	●	●	To determine amount of water to add/remove.
	Density testing	●	●	●	●	●	●	●	To evaluate changes in density between untreated and treated waste and to determine volume increase.
	Chemical: Total organic content	●	●	●	●	●	●	●	To determine reagent requirements.
	pH	●	●	●	●	●	●	●	To determine whether soils are acid or alkaline.
	Alkalinity								pH is being analyzed.
	Interfering compounds								These compounds vary with the type of stabilization process and are not known at this time as no specific stabilization processes have been identified at this time.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
					Vitrification				
Soils/ sludges	**Physical:** Depth of contamination and water table	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives vitrification does not appear to be a potential treatment option. Parameters that have been selected, were selected solely because their measurement is required to evaluate another technology.
	Soil permeability	●	●	●	●	●	●	●	
	Metal content of waste material and placement of metals within the waste								
	Combustible liquid/solid content of waste								
	Rubble content of waste								
	Void volumes								
	Moisture content	●	●	●	●	●	●	●	
	Particle-size analysis	●	●	●	●	●	●	●	
					Thermal Treatment				
Soils/ sludges	**Physical:** Moisture content	●	●	●	●	●	●	●	Affects heat value and material handling.
	Ash content								For soils this can be estimated based on knowledge of organic and moisture content.
	Ash fusion temperature								Only lower temperature processes have been identified. Slagging of soils is not expected at these temperatures.
	Heat value								For soils, these values can be estimated based upon a knowledge of organic content and moisture content.
	Chemical: Volatile organics, semi-volatile organics	●	●	●	●	●	●	●	Allows determination of principal organic hazardous constituents.
	Principal organic hazardous constituents	●	●	●	●	●	●	●	Allows determination of destruction and removal efficiency.
	Total halogens								To determine air pollution control devices for control of acid gases. Many halogen containing compounds are being tested for CLP TAL.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Total sulfur, total nitrogen					●	●		Emissions of SO_X and NO_X are regulated; to determine air pollution devices.
	Phosphorus					●	●		Organic phosphorus compounds may contribute to refractory attack and slagging problems.
	PCBs and dioxins (if suspected)			●		●	●		99.0000% destruction and removal efficiency required for PCBs; safety considerations; incineration is required if greater than 500 ppm PCBs present.
	Metals	●	●	●	●	●	●	●	Volatile metals (Hg, Pb, Cd, Zn, As, Sn) may require flue-gas treatment; other metals may concentrate in ash. Trivalent chromium may be oxidized to hexavalent chromium, which is more toxic.
Liquids	**Physical:** Viscosity								Based upon initial screening of process options and scoping of alternatives, thermal treatment of liquids does not appear to be a potential treatment option. Parameters that have been selected, where selected solely because their measurement is required to evaluate another technology.
	Total solids content								
	Particle-size distribution of solid phases								
	Heat value								
	Chemical: Volatile organics, semi-volatile organics	●	●	●	●	●	●	●	
	Principal organic hazardous constituents								
	Total halogens								
	Total sulfur, total nitrogen								
	Phosphorus								
	PCBs, dioxins (if suspected)			●		●	●		
	Metals	●	●	●	●	●	●	●	
					Rotary kiln				
Soils/ sludges	**Physical:** Particle-size distribution	●	●	●	●	●	●	●	Fine particle size results in high particulate loading and slagging. Large particle size may present feeding problems.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
Debris	**Physical:** Amount, description of materials								Oversized debris presents handling problems and kiln refractory loss.
	Presence of spherical or cylindrical wastes								Spherical or cylindrical waste can roll through kiln before combusting.
				Fluidized-bed					
Soils/ sludges	**Physical:** Ash fusion temperature								Based upon initial screening of process options and scoping of alternatives, fluidized bed incineration does not appear to be a potential treatment option. Parameters that have been selected were selected solely because their measurement is required to evaluate another technology.
	Ash content								
	Bulk density								
				Thermal Desorption					
Soils/ sludges	**Physical:** Moisture content	●	●	●	●	●	●	●	Affects heating and materials handling.
	Particle-size distribution	●	●	●	●	●	●	●	Large particles result in poor performance. Fine silt or clay generate fugitive dusts.
	Chemical: pH	●	●	●	●	●	●	●	Very high or very low pH waste may corrode equipment.
	Volatile organic contaminants	●	●	●	●	●	●	●	To determine concentration of target constituents, post treatment needs.
	Volatile metals	●	●	●	●	●	●	●	To determine concentration of target constituents, post treatment needs.
	Nonvolatile metals	●	●	●	●	●	●	●	To determine post treatment needs.
	Total chlorine	●	●	●	●	●	●	●	Presence can effect volatilization of some metal.
	Total organic content	●	●	●	●	●	●	●	Limited to ~ 10 percent or less.
Liquids	**Physical:** Total solids content								Liquids will not be treated by thermal desorption.

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
				Vapor extraction					
-Vacuum extraction *-Steam-enhanced* *-Hot-air-enhanced*									
Soils/ sludges	**Physical:** Vapor pressure of contaminants	●	●	●	●	●	●	●	To estimate ease of volatilization.
	Soil permeability, porosity, particle-size distribution	●	●	●	●	●	●	●	To determine if the soil matrix will allow adequate air and fluid movement.
	Depth of contamination and water table	●	●	●	●	●	●	●	To determine relative distance; technology applicable in vadose zone.
				Solidification/Stabilization (in-situ)					
-Pozzolanic *-Polymerization* *-Precipitation*									
Soils/ sludges	**Physical:** Presence of subsurface barriers (e.g., drums, large objects, debris, geologic formations)								To assess the feasibility of adequately delivering and mixing the S/S agents.
	Depth to first confining layer	●	●	●	●	●	●	●	To determine required depth of treatment.
				Soil flushing					
-Steam/hot water *-Surfacant* *-Solvent*									
Soils/ sludges	**Physical:** Presence of subsurface barriers (e.g., drums, large objects, debris, geologic formations)								Based upon initial screening of process options and scoping of alternatives, soil flushing does not appear to be a potential treatment option. Parameters that have been selected were selected solely because their measurement is required to evaluate another technology.
	Hydraulic conductivity	●	●	●	●	●	●	●	

TABLE 6-5 (Continued)
DATA REQUIREMENTS FOR TREATMENT TECHNOLOGIES

Matrix	Parameter	Rubble Fill @ Bunker A-86	Torpedo Shops	Goss Cove Landfill	Spent Acid	Area A/ OBDA	DRMO	Lower Subase	Comments
	Moisture content (for vadose zone)	●	●	●	●	●	●	●	
	Soil/water partition coefficient								
	Octanol/water partition coefficient								
	Cation exchange capacity	●	●	●	●	●	●	●	
	Alkalinity of soil								
	Chemical: Major cations/anions present in soil								
Vitrification									
Soils/ sludges	**Physical:** Depth of contamination and water table	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives, vitrification does not appear to be a potential treatment option. Parameters that have been selected were selected solely because their measurement is required to evaluate another technology.
Microbial degradation									
-Aerobic									
Soils/ sludges	**Physical** Permeability of soil	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives, microbial degradation does not appear to be a potential treatment option. Parameters that have been selected were selected solely because their measurement is required to evaluate another technology.
	Chemical/biological: Contaminant concentration and toxicity	●	●	●	●	●	●	●	
-Anaerobic									
Soils/ sludges	**Chemical/biological:** Contaminant concentration and toxicity	●	●	●	●	●	●	●	Based upon initial screening of process options and scoping of alternatives, microbial degradation does not appear to be a potential treatment option. Parameters that have been selected were selected solely because their measurement is required to evaluate another technology.

6.1.1.2 Risk Assessment

Activity in this area is negligible; however, based on the elevated levels of PAHs and arsenic, there could be potential health risks if exposures were to occur under some future use condition.

Potential target remediation levels for PAHs in soils are in the range of 25 to 100 ppm.

6.1.1.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that may be included in potential alternatives are presented in Table 6-6.

6.1.2 Torpedo Shops

6.1.2.1 Potential ARARs

Potentially significant ARARs that apply to the Torpedo Shops include federal and state drinking and surface water standards and criteria. Chemical-specific ARAR/TBC values that have been exceeded during the Step I investigations are presented in Table 6-7.

No significant location-specific ARARs were identified that are applicable to this site.

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site. Of note are the state and federal underground storage tank requirements and the Toxic Substance Control Act (TSCA) PCB regulations.

6.1.2.2 Risk Assessment

The most significant exposure scenario identified to date relates to utility repairs/installations within the former septic system area. Based on the relatively low levels of chemicals present at the site, and the health risk calculations made for utility workers at other sites (Area A Landfill, Lower Subase), the health risks associated with this exposure scenario are qualitatively predicted to be negligible; however, if an undefined source area of VOC contaminated soil exists, it could potentially present an unacceptable risk under the scenario. Based on the lack of potable water supply wells for existing and projected future land use in the area, there is no exposure; therefore, no human health risks are associated with the chemical constituents in the ground water. Because the site is developed, there are no significant ecological risks identified at this time.

TABLE 6-6 RUBBLE FILL AT BUNKER A-86 PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS			
Remedial Action Objective	**General Response Actions**	**Technology Types**	**Remedial Alternative Potential Process Options**
Reduce leachate generation from arsenic and PAHs contaminated soils. Reduce exposure of workers to arsenic and PAH in soils.	Limited Action	Access Restrictions	Soil and Membrane Cap, *In situ* Stabilization, Excavation, Thermal Desorption Treatment or Stabilization, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Landfill, Thermal	
	Disposal (onsite & offsite)	Landfill, Reuse, Thermal	
Control and treat potentially contaminated ground water.	Containment	Ground Water Controls, Horizontal Barriers, Vertical Barriers	Pump and Treat System, Chemical Precipitation, Biological or Carbon Adsorption Treatment
	Removal	Subsurface Drains, Pumping	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical	
	Disposal (onsite & offsite)	Discharge to POTW, Discharge to Surface Water, Discharge to Ground Water, Transportation to TSDF	

TABLE 6-7 TORPEDO SHOPS SUMMARY OF ARAR/TBC VALUES EXCEEDED		
Requirement	**Media**	**Chemical(s) of Concern**
ARAR		
U.S. EPA Water Quality Criteria (U.S. EPA 1986) CTDEP Water Quality Standards (CTDEP 1992)	Surface Water	Copper, Lead, Zinc
TBC		
CTDEP Guidance (CTDEP Undated)	Soil	Arsenic, Selenium, Benzene
U.S. EPA Secondary MCL (U.S. EPA 1991)	Ground Water	Iron, Manganese
U.S. EPA Health Advisory (U.S. EPA 1991)	Ground Water	Boron[1], Antimony, Vanadium
CTDOHS Advisory Level (CTDOHS 1992)	Ground Water	Sodium
Note: 1. Previously collected boron data may be erroneous due to sulfur interference.		

6.1.2.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that would be included in potential alternatives are presented in Table 6-8.

TABLE 6-8
TORPEDO SHOPS
PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS

Remedial Action Objective	General Response Actions	Technology Types	Alternative Potential Process Options
Reduce leachate generation from solvent contaminated soils. Reduce exposure of workers to VOCs in soils.	Limited Action	Access Restrictions	Soil and Membrane Cap, *In situ* Soil Venting, Excavation, Air Stripping or Thermal Desorption Treatment, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Thermal	
	Disposal (onsite & offsite)	Thermal, Landfill, Reuse	
Control and treat potentially contaminated ground water.	Containment	Ground Water Controls, Horizontal Barriers, Vertical Barriers	*In situ* Air Sparging, *In situ* Biological Pump and Treat System, Air Stripping, Biological or Carbon Adsorption Treatment
	Removal	Subsurface Drains, Pumping	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical	
	Disposal (onsite & offsite)	Discharge to POTW, Discharge to Surface Water, Discharge to Ground Water, Transportation to TSDF	

6.1.3 Goss Cove Landfill

6.1.3.1 Potential ARARs

Potentially significant chemical-specific ARARs applicable to this site include federal and state water quality standards and criteria. Chemical-specific ARAR/TBC values that have been exceeded during the Step I investigations are presented in Table 6-9. Drinking water standards are presently categorized as potential ARARs at this site, as ground water is not an existing potential source of drinking water due to salt water intrusion.

Potentially significant location-specific ARARs include the following:

- Federal CWA Section 404 (40 CFR 230 and 33 CFR 320-330)

TABLE 6-9 GOSS COVE LANDFILL SUMMARY OF ARAR/TBC VALUES EXCEEDED		
Requirements	**Media**	**Chemical(s) of Concern**
Potential ARAR		
CTDOHS/U.S. EPA MCL (CTDOHS 1992; U.S. EPA 1991)	Ground Water	Benzene, Vinyl Chloride, Barium
TBC		
CTDEP Guidance (CTDEP Undated)	Soil	Arsenic, Barium, Cadmium, Chromium, Lead, Silver, Benzene, Tetrachloroethene, Toluene
U.S. EPA Tolerance Level (40 CFR Part 180)	Soil	DDT
U.S. EPA Secondary MCL (U.S. EPA 1991)	Ground Water	Iron, Manganese
CTDOHS Advisory Level (CTDOHS 1992)	Ground Water	Sodium, Alpha and Beta Radiation
U.S. EPA Health Advisory (U.S. EPA 1991)	Ground Water	Boron[1], Naphthalene, Fluorene
CTDEP WQS (CTDEP 1992)	Ground Water	Phenanthrene
Note: 1. Previously collected boron data may be erroneous due to sulfur interference.		

- Federal Executive Orders 11988 (Floodplain Management)
- Federal Fish and Wildlife Coordination Act (16 USC Part 661 et seq., 40 CFR Part 122.29)
- Federal and State Coastal Zone Management Act (16 USC Part 1451 et seq., 22a-92 and 94 CGS)
- State Regulation of Dredge and Fill in Tidal, Coastal, or Navigable Waters (229-359 to 363 CGS)

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site. Of note are the federal and state solid waste management requirements (40 CFR 240 to 258, 22a-209-1 to 13 RCSA).

6.1.3.2 Risk Assessment

Future construction and excavation activities in the parking lot could result in risk to workers, if proper health and safety procedures are not followed. There is some potential that vapors from within the landfill could enter the museum building; however, this possibility has not been fully investigated to date. There is also a possibility that children could come in contact with sediments in Goss Cove. At present, there are no data on the level of contaminants in these sediments.

Potential target remediation levels for various contaminated soils at this site, based on its similarities to DRMO, are:

- PCB: Maximum = 10 ppm; Average = 4 ppm; Maximum = 2ppm (CTDEP)
- PAH (carcinogenic): Maximum = 100 ppm; Average = 24 ppm
- Lead: Average = 1,000 ppm

Although ground water quality exceeded drinking water standards, no drinking water wells are within the affected area, nor could they be due to the proximity to the brackish Thames River.

Ground water from Goss Cove Landfill discharges to the Thames River. Based on the data presented in this report, a qualitative assessment indicates that contaminant concentrations in ground water at these sites are expected to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the Thames River estuary. Risks to aquatic life due to contaminants in ground water discharged from the site are also expected to be low. A further assessment of this issue is included in this Work Plan.

6.1.3.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that would be included in potential alternatives are presented in Table 6-10.

6.1.4 Spent Acid Storage and Disposal Area

6.1.4.1 Potential ARARs

Potentially significant chemical-specific ARARs applicable to this site include federal and state drinking water standards and hazardous waste standards. No chemical-specific ARAR values were exceeded in soils for arsenic, cadmium, chromium, or lead. TCLP lead levels were detected in four samples above the 5.0 ppm level which defines a hazardous waste and above the cleanup standard of 0.05 ppm in CTDEP guidance.

No significant location-specific ARARs were identified that are applicable to this site.

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site. Of note are the federal and state hazardous waste management and facility siting regulations (40 CFR 260 to 272, 22a-449(c) 100 to 110 RCSA, 22a-116-B1 to 11 RCSA).

TABLE 6-10
GOSS COVE LANDFILL
PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS

Remedial Action Objective	General Response Actions	Technology Types	Alternative Potential Process Options
Reduce infiltration through landfill and prevent erosion of landfill surface soils.	Containment	Horizontal Barriers, Stormwater Control	Soil and Membrane Cap
Reduce exposure of workers to PCBs, PAH, and lead in soils and prevent erosion.	Limited Action	Access Restrictions	Excavation, Thermal Desorption or Stabilization Treatment, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Thermal	
	Disposal (onsite & offsite)	Landfill, Reuse, Thermal	
Reduce leachate generation from solvent and PAH contaminated soils and control and treat ground water contamination as necessary to protect Thames River water quality.	Limited Action	Access Restrictions	Pump and Treat System, Chemical Precipitation, Biological, Air Stripping or Carbon Adsorption Treatment
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Landfill	
	Disposal (onsite & offsite)	Landfill, Reuse	

6.1.4.2 Risk Assessment

The area between Buildings 409 and 410 is scheduled for construction of a new building. There may be some risk to construction or utility maintenance personnel associated with contact with contaminated subsurface soils if they do not follow appropriate health and safety procedures. Based on similar levels of lead at DRMO, and the resulting risk for construction workers (Hazardous Waste Storage Building Construction), the risks at this site to unprotected construction workers could be above acceptable levels. The site is developed; therefore, there are no significant ecological risks.

Potential target remedial action levels for lead in soils will be in the 500 to 1,000 ppm range at this site.

6.1.4.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that would be included in potential alternatives are presented in Table 6-11.

TABLE 6-11
SPENT ACID STORAGE AND DISPOSAL AREA
PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS

Remedial Action Objective	General Response Actions	Technology Types	Alternative Potential Process Options
Reduce exposure of workers to lead in soils and prevent erosion.	Limited Action	Access Restrictions	Soil and Membrane Cap, *In situ* Stabilization, Excavation, Thermal Desorption (PAH) and Stabilization Treatment, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Thermal	
	Disposal (onsite & offsite)	Landfill, Reuse, Thermal	
Reduce leachate generation from lead contaminated soils and control and treat any contaminated ground water.	Limited Action	Access Restrictions	Pump & Treat System, Chemical Precipitation Treatment
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Landfill	
	Disposal (onsite & offsite)	Landfill, Reuse	

6.2 Supplemental Step II Investigations

6.2.1 Area A

6.2.1.1 Potential ARARs

Potentially significant chemical-specific ARARs applicable to this site include federal and state drinking and surface water quality standards and criteria. Chemical-specific ARAR/TBC values that have been exceeded during the Phase I RI are presented in Table 6-12.

TABLE 6-12
AREA A
SUMMARY OF ARAR/TBC VALUES EXCEEDED

Requirement	Media	Chemical(s) of Concern
ARAR		
U.S. EPA/CTDOHS MCL (U.S. EPA 1991; CTDOHS 1992)	Ground Water	Cadmium, Lead, Benzene, Trichloroethene
U.S. EPA/CTDEP WQC (U.S. EPA 1986; CTDEP 1992)	Surface Water	Cadmium, Copper, Iron, Lead, Manganese, Zinc, Mercury, DDD
TBC		
CTDOHS Action Level (CTDOHS 1990)	Ground Water	PCB
U.S. EPA Secondary MCL (U.S. EPA 1991)	Ground Water	Iron, Manganese, Aluminum
U.S. EPA Health Advisory (U.S. EPA 1991)	Ground Water	1,4-Dichlorobenzene, 1,2,4-trichlorobenzene
CTDOHS Screening Level (CTDOHS 1992)	Ground Water	Sodium, Gross Alpha and Beta Radiation
U.S. EPA TSCA Guidance (40 CFR Part 761)	Soil	PCB
U.S. EPA Tolerance Level (40 CFR Part 180)	Soil	DDT
CTDEP Guidance (CTDEP Undated)	Soil	Arsenic, Cadmium, Chromium, Lead, Mercury, Selenium, Silver, Ethylbenzene, Xylene, Benzene, Trichloroethene, Tetrachloroethene

Potential significant location-specific ARARs include the following:

- Federal CWA Section 404 (40 CFR 230 and 33 CFR 320-330)
- Federal Executive Orders 11990 (Protection of Wetlands) and 11988 (Floodplain Management)
- Federal Fish and Wildlife Coordination Act (16 USC Part 661 et seq., 40 CFR Part 122.29)

- Federal and State Coastal Zone Management Act (16 USC Part 1451 et seq., 22a-92 and 94 CGS)

- State Regulation of Dredge and Fill in Tidal, Coastal, or Navigable Waters (22a-359 to 363 CGS)

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site. ARARs of note are listed below:

- Federal and State Solid Waste Standards (40 CFR 240 to 258, 22a-209-1 to 13 RCSA)

- Federal and State Water Discharge Permit Regulations (40 CFR 122 to 125, 22a 430-1 to 8 RCSA)

- Connecticut Water Diversion Policy Act (22a-372 and 377 RCSA)

- U.S. EPA and Corps of Engineers Rules on Activities in Wetlands and Watercourses (33 USC 404, 33 CFR 320-330, 40 CFR 230)

6.2.1.2 Risk Assessment

Human Health Risk Assessment: Several identified exposure pathways were evaluated for Area A. They are listed as follows:

- Workers repairing utilities within Area A.

- Weapons Center personnel exposed to fugitive dusts from the Area A Landfill.

- Workers moving pallets within the Area A Landfill.

- Navy personnel exposed to fugitive dust while engaged in recreational activities near the Area A Landfill.

- Groton/Ledyard residents exposed to fugitive dust from the Area A Landfill.

- Citizens attending car auctions at the Area A Landfill.

- Subase children exploring woods within Area A.

- Subase children exploring streambeds and the Area A Wetland.

- Children swimming in North Lake.

Negligible or *de minimus* risks were calculated for workers repairing utilities within Area

A, Weapons Center personnel exposed to fugitive dust, Navy personnel exposed to fugitive dust while engaged in recreational activities, citizens attending car auctions, and children swimming in North Lake.

The following exposure scenarios did exhibit risks which fell within the one in one hundred thousand to one in one million excess cancer risk range:

- Workers moving pallets within the Area A Landfill (risk due to presence of PCBs in landfill surface soils).

- Subase children exploring woods within Area A (risk due to PCBs in landfill surface soils).

- Subase children exploring streambeds and the Area A Wetland (risk due to pesticides in stream sediments).

Potential remediation target levels for PCBs in landfill soils and DDTR in sediments are as follows:

- PCB: Maximum = 10 ppm; Average = 4 ppm;
  Maximum = 2 ppm (CTDEP)
- DDTR: Average = 25 ppm

Ground water within Area A contains VOCs and cadmium above ARAR and TBC drinking water standard/guidance values, indicating a potential health risk if the water were to be consumed. No potable water supply wells exist, or are planned by the Navy, in the suspected potentially affected downgradient area. Additional monitoring wells will be installed southeast of the Area A Landfill. Should they indicate that ground water migrates in a southeasterly direction, several residential wells could be affected downgradient of this site. The Navy owns the land within the potentially affected area. Therefore, under existing and projected future land use conditions, no exposure pathways exists for human consumption of degraded ground water unless it is determined that there is a southeasterly component of ground water flow. However, this scenario will be evaluated in the risk assessment included in this Work Plan.

<u>Ecological Risk Assessment</u>: The ecological risk assessment addressed risks to a variety of trophic levels in the terrestrial and aquatic food chain in Area A. On the lower level of the food chain, risks to plants were low. Plants are unlikely to accumulate organic compounds to a great degree. Metals concentrations in soils and sediments were, in general, below levels that may adversely affect plants or higher trophic level organisms that feed on plants. However, cadmium concentrations in soil samples from OBDA exceeded recommended levels protective of plants and organisms consuming plants.

Risks to terrestrial organisms due to DDTR in soil were greatest for soil invertebrates in OBDA. The risks to soil invertebrates in the wetland and downstream areas due to contaminants were low.

The assessment indicates that DDTR in sediments of streams and ponds in the Area A Downstream poses a potentially great risk to biota. Organisms with the greatest exposure to DDTR contaminated sediments are benthic invertebrates. Frogs are also directly exposed to sediment during winter months. Other organisms potentially affected by these sediments are fish, if they are present in the ponds. Birds such as duck and heron, and mammals such as raccoon and otter, may be exposed to DDTR by feeding on contaminated aquatic invertebrates and frogs, but this exposure will only account for a small part of their diet because they are likely to feed over a much greater geographical area than Area A.

Higher level organisms in the food chain may be exposed to DDTR and, to a lesser extent, to PAHs bioaccumulated in soil invertebrates. The greatest potential risks are to small mammals such as the shrew that consume a diet consisting mainly of soil invertebrates at a rate equivalent to their body weight per day. Based on the assumption that they consume only contaminated soil invertebrates, these animals are at potential risk. Risks to herbivorous birds and small mammals are much smaller than for the maximally exposed shrew since they have much less exposure to DDTR. Based on the low body burdens of DDTR in catbirds collected from Area A, risks to birds feeding on soil invertebrates appear to be low. This may be because the area in which they feed is large in comparison to the portion of the OBDA with elevated levels of DDTR in soil.

The aquatic organisms in Area A at greatest risk are those exposed to elevated levels of DDTR in pond and stream sediments in the Downstream area. Therefore, benthic invertebrates and possibly frogs are at greatest potential risk. DDTR contaminated sediments have been transported by the streams in the downstream portion of Area A to the Thames River. However, DDTR concentrations, and therefore potential risks due to DDTR, are much lower at the stream outfalls than upstream.

Depending on the results of the ecological assessment, remediation target levels for ecological protection may be lower than those developed to protect human health.

6.2.1.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that would be included in potential alternatives are presented in Table 6-13.

6.2.2 DRMO

6.2.2.1 Potential ARARs

Potentially significant chemical-specific ARARs applicable to this site include federal and state water quality standards and criteria. Chemical-specific ARAR/TBC values that have been exceeded during the Step I investigation are presented in Table 6-14. Drinking water standards are presently categorized as potential-not-actual ARARs at this site as ground water is not a potential source of drinking water due to salt water intrusion.

TABLE 6-13 AREA A PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS			
Remedial Action Objective	**General Response Actions**	**Technology Types**	**Alternative Potential Process Options**
Reduce infiltration through landfill and prevent erosion of landfill surface soils.	Containment	Horizontal Barriers, Stormwater Control	Soil and Membrane Cap
Reduce exposure of workers to PCBs in surface soils.	Limited Action	Access Restrictions	Excavation, Soil and Membrane Cap, Thermal Desorption or Incineration Treatment, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical	
	Disposal (onsite & offsite)	Thermal, Landfill, Reuse	
Reduce exposure of children and biota to DDTR in sediments and prevent transport of sediments.	Limited Action	Access Restrictions	Fence, Soil Cap with Water Diversion, Dredging, Dewatering, Thermal Desorption or Incineration Treatment, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation, Dredging	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical	
	Disposal (onsite & offsite)	Thermal, Landfill, Reuse	
Control and treat ground water with constituent concentration that exceeds ARARs.	Containment	Ground Water Controls, Horizontal Barriers, Vertical Barriers	Pump and Treat System, Activated Carbon, Air Stripping, Biological or Chemical Precipitation Treatment
	Removal	Subsurface Drains, Pumping	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Landfill	
	Disposal (onsite & offsite)	Discharge to POTW, Discharge to Surface Water, Discharge to Ground Water, Transportation to TSDF	

TABLE 6-14 DRMO SUMMARY OF ARAR/TBC VALUES EXCEEDED		
Requirement	**Media**	**Chemical(s) of Concern**
Potential ARAR		
CTDOHS and U.S. EPA MCL (U.S. EPA 1991) (CTDOHS 1992)	Ground Water	Selenium, Trichloroethene
TBC		
CTDOHS Screening Level (CTDOHS 1992)	Ground Water	Sodium, Gross Alpha and Beta Radiation
U.S. EPA Secondary MCL (U.S. EPA 1991)	Ground Water	Iron, Manganese
U.S. EPA Health Advisory (U.S. EPA 1991)	Ground Water	Boron[1]
U.S. EPA TSCA Guidance (40 CFR Part 761)	Soil	PCB
U.S. EPA Tolerance Level (40 CFR Part 180)	Soil	DDT
CTDEP Guidance (CTDEP Undated)	Soil	Barium, Cadmium, Chromium, Lead, Mercury, Silver, 1,2-Dichloroethane, 1,2-Dichloroethene, Trichloroethene, Vinyl Chloride
Note: 1. Previously collected boron data may be erroneous due to sulfur interference.		

Potentially significant location-specific ARARs include the following:

- Federal CWA Section 404 (40 CFR 230 and 33 CFR 320-330)
- Federal Executive Order 11988 (Floodplain Management)
- Federal and State Fish and Wildlife Coordination Act (16 USC Part 661 et. seq., 40 CFR Part 122.29)
- Federal and State Coastal Zone Management Act (16 USC Part 1451 et. seq., 22a-92 and 94 CGS)
- State Regulation of Dredge and Fill in Tidal, Coastal or Navigable Waters (22a-359 to 363 CGS)

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site. Of note are the federal and state solid and hazardous waste management requirements (40 CFR 240 to 258, 22a-209-1 to 13 RCSA, 40 CFR 260 to 272, 22a-449(c) 100 to 110 RCSA).

6.2.2.2 Risk Assessment

Human Health Risk Assessment: Several identified exposure pathways were evaluated for DRMO. They are listed as follows:

- Citizens attending auctions and public sales at DRMO.
- Navy workers sorting scrap metal.
- Workers repairing/installing utilities.
- Construction of a Hazardous Waste Storage Facility.
- Exposure to fugitive dust from DRMO.

Negligible or *de minimus* risks were calculated for citizens attending auctions and public sales, utility workers repairing/installing utilities, and exposure to fugitive dust from DRMO. The following exposure scenarios did exhibit risks which fall within the one in ten thousand and one in one million excess cancer risk range:

- Navy workers sorting scrap metal (risk due to PCBs, PAHs, and beryllium in surface soils).

- Construction of a Hazardous Waste Storage Facility (risk due to elevated level of lead at northern portion of site).

Although ground water quality exceeds drinking water standards, no drinking water wells are within the affected area, nor are they feasible due to the proximity of the brackish Thames River.

Potential remediation target levels for various contaminants in soils are as follows:

- PCBs: Maximum = 10 ppm; Average = 4 ppm;
  Maximum = 2 ppm (CTDEP)
- CPAH: Maximum = 100 ppm; Average = 24 ppm
- Lead: Average = 1,000 ppm

Ecological Risk Assessment: Ground water from this site discharges to the Thames River. Based on the available data, contaminant concentrations in ground water are predicted to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the Thames River estuary. Risks to fish due to contaminants in ground water discharge from these sites are expected to be low. Further assessment of ecological risks are included in this Work Plan.

6.2.2.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that would be included in potential alternatives are presented in Table 6-15.

TABLE 6-15 DRMO PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS			
Remedial Action Objective	**General Response Actions**	**Technology Types**	**Alternative Potential Process Options**
Reduce infiltration through landfill and prevent erosion of landfill surface soils.	Containment	Horizontal Barriers, Stormwater Control	Soil and Membrane Cap
Reduce exposure of workers to PCBs, PAH, and lead in soils and prevent erosion.	Limited Action	Access Restrictions	Excavation, Thermal Desorption or Stabilization Treatment, Offsite Landfill, Offsite Incineration
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Thermal	
	Disposal (onsite & offsite)	Landfill, Reuse	
Reduce leachate generation from contaminated soils and control and treat contaminated ground water as necessary to protect Thames River water quality.	Limited Action	Access Restrictions	Pump & Treat System, Chemical Precipitation, Biological, Air Stripping or Carbon Adsorption Treatment
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Landfill	
	Disposal (onsite & offsite)	Landfill, Reuse	

6.2.3 Lower Subase

6.2.3.1 Potential ARARs

Potentially significant chemical-specific ARARs applicable to this site include federal and state water quality standards and criteria. Chemical-specific ARAR/TBC values that have been exceeded during the Step I investigation are presented in Table 6-16. Drinking water standards are presently categorized as potential-not-actual ARARs at this site as ground water is not a potential source of drinking water due to salt water intrusion.

Potentially significant location-specific ARARs include the following:

- Federal CWA Section 404 (40 CFR 230 and 33 CFR 320-330)
- Federal Executive Order 11988 (Floodplain Management)
- Federal Fish and Wildlife Coordination Act (16 USC Part 661 et. seq., 40 CFR Part 122.29)
- Federal and State Coastal Zone Management Act (16 USC Part 1451 et. seq., 22a-92 and 94 CGS)
- State Regulation of Dredge and Fill in Tidal, Coastal or Navigable Waters (22a-359 to 363 CGS)

TABLE 6-16 LOWER SUBASE SUMMARY OF ARAR/TBC VALUES		
Requirement	**Media**	**Chemical(s) of Concern**
Potential ARAR		
U.S. EPA and CTDOHS MCL (U.S. EPA 1991) (CTDOHS 1992)	Ground Water	Cadmium, Lead, Selenium, Benzene, 1,1-Dichloroethene, Vinyl Chloride
TBC		
CTDOHS Screening Level (CTDOHS 1992)	Ground Water	Sodium
U.S. EPA Secondary MCL (U.S. EPA 1991)	Ground Water	Iron, Manganese, Aluminum
U.S. EPA Health Advisory (U.S. EPA 1991)	Ground Water	Boron[1], Vanadium, Thallium
CTDEP Guidance (CTDEP Undated)	Soil	Arsenic, Lead, Chromium, Tetrachloroethene
Note: 1. Previously collected boron data may be erroneous due to sulfur interference.		

Several action-specific ARARs were identified as potentially applicable to this site. Whether or not any of these will apply depends on the type of remedial action, if any, to be implemented at this site. Of note are the federal and state hazardous waste management requirements (40 CFR 260 to 272, 22a-449 (c) 100 to 110 RCSA).

6.2.3.2 Risk Assessment

Human Health Risk Assessment: Several identified exposure pathways were evaluated for the Lower Subase. They are listed as follows:

- Utility workers exposed to soils and ground water in utility vaults.
- Utility workers exposed to soils and ground water during utility excavation work.
- Future construction of buildings in the Lower Subase.

Negligible or *de minimus* risks were calculated for these exposure scenarios.

Although ground water quality exceeds drinking water standards in a few wells, no drinking water wells exist in the affected area, nor are they feasible due to the proximity of the site to the brackish Thames River.

Potential remediation target levels for lead in soils to protect human health will probably be in the range of 500 to 1,000 ppm.

Ecological Risk Assessment: Ground water from the Lower Subase discharges to the

Thames River. Based on available data, contaminant concentrations in ground water are projected to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the much greater flow (compared to ground water flow) in the Thames River estuary. Risks to aquatic life due to contaminants in ground water discharge from these sites are expected to be low. Further assessment of potential ecological risks are included in this Work Plan.

6.2.3.3 Preliminary Remedial Action Objectives and Alternatives

Preliminary remedial action objectives and alternative process options have been developed for this site to assist in identifying data requirements for this investigation. The remedial action objectives and corresponding process options that would be included in potential alternatives are presented in Table 6-17.

TABLE 6-17
LOWER SUBASE
REMEDIAL ACTION OBJECTIVES AND ALTERNATIVE PROCESS OPTIONS

Remedial Action Objective	General Response Actions	Technology Types	Alternative Potential Process Options
Reduce exposure of workers to lead in soils and prevent erosion.	Limited Action	Access Restrictions	Soil and Membrane Cap
	Containment	Horizontal Barriers, Surface Water Control	
Reduce leachate generation from lead and VOC contaminated soils, and control and treat contaminated ground water as necessary to protect Thames River water quality.	Limited Action	Access Restrictions	Pump & Treat System, Chemical Precipitation, Treatment, Biological, Air Stripping or Carbon Adsorption Treatment
	Containment	Horizontal Barriers, Surface Water Control	
	Removal	Excavation	
	Treatment (*in situ* & aboveground)	Biological, Physical/Chemical, Landfill	
	Disposal (onsite & offsite)	Landfill, Reuse	
Remove and treat or dispose of any recoverable subsurface free product.	Unknown	Treatment (*In situ* & Aboveground)	Subsurface Drains, Pumping
		Disposal (Onsite & Offsite)	Biological, Physical/ Chemical, Thermal, Reuse

7.0 REMEDIAL INVESTIGATION AND FEASIBILITY OBJECTIVES

The Step II Remedial Investigation/Feasibility Studies involve sites which have undergone an initial (i.e., Step I) field sampling/analysis program in which contamination was determined to be present. Step II investigations include comprehensive site studies designed to determine the nature and extent of contamination, to assess associated health and environmental risks and to conduct feasibility studies to evaluate remedial (cleanup) options.

Supplemental Step II Remedial Investigations involve sites that have undergone Step II investigations for which further supplemental information is required. This information is needed to further define the extent of contamination and further assess health and ecological risks in order to allow completion of the Feasibility Study. Specific items included in the supplemental investigation were either recommendations of the Phase I RI or requests of the Technical Review Committee.

The overall goals of the RI/FS are to:

- Conduct a field investigation program for collecting data to further quantify the nature and extent of contamination in the ground water, surface and subsurface soils, surface water/sediments, and air (as applicable).

- Develop base-wide ground water contour and bedrock elevation maps using information collected from each of the sites, as well as outcrop information, and any other readily available information.

- Determine if unacceptable risk exists to human health or the environment.

- Develop and evaluate remedial action alternatives, if unacceptable risks are identified.

The following sections describe site-specific objectives of the remedial investigation for each site. The human health and ecological risk assessment investigation plan objectives are provided in Sections 4.0 and 5.0 and are not repeated herein. Also provided are summary tables which specify RI objectives and actions, chemical constituent selection rationale, and site sampling plan summary tables. Figures illustrating existing and proposed sample locations are provided for each site.

This section provides a general overview of the work to be evaluated. Specific details of the field investigation, including protocols and procedures, are provided in the Field Sampling Plan.

7.1 Supplemental Step I Investigations

7.1.1 CBU Drum Storage Area

The specific goals of this investigation include the overall goals listed in Section 7.0 and the following:

- Collect supplemental analytical data to confirm that contaminants are not present at levels of concern.
- Determine the nature of any hazardous substances in soil.
- Determine if hazardous substances are present in ground water.
- Collect data for a qualitative human health risk assessment.

The remedial investigation objectives and associated investigative actions are included in Table 7-1. The rationale for selection of constituents for analysis is provided in Table 7-2. Table 7-3 provides details of the field sampling plan, including location, number and type of samples, location rationale, and analysis requirements.

Figure 7-1 illustrates the proposed sample locations.

The general approach to be used in this investigation is presented below. Preliminary investigations identified relatively low levels of VOCs, SVOCs, total petroleum hydrocarbons, and metals in some of the samples. The pesticide DDD was also detected in one of the samples. The supplemental Step I investigation is designed to further confirm that chemical contaminants are not present at levels of concern. The investigations will assess whether contamination has impacted deeper soils and ground water in the former drum storage area. The field program will consist of a series of soil borings, the installation of a monitoring well, and collection of soil (surface and subsurface) and ground water samples for chemical analysis. Test borings will be drilled for geologic and chemical characterization of subsurface media and fill materials. The monitoring well will be installed to assess site ground water quality.

7.1.2 OBDANE

The site-specific goals of this investigation include the overall goals listed in Section 7.0 and the following:

- Collect supplemental analytical data to confirm that contaminants are not present at levels of concern.
- Determine the nature of any hazardous substances in soil.
- Determine if hazardous substances are present in ground water.

TABLE 7-1
CBU DRUM STORAGE AREA
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geologic features. /Geologic features have not been completely mapped.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevations.
Geologic Investigation	Characterize stratigraphy of overburden. Characterize the physical nature of fill materials in the CBU Drum Storage Area. /No information regarding stratigraphy of overburden has been collected in this area.	Perform a series of test borings; collect continuous core samples.
Hydrogeologic Investigation	Determine appropriate screen interval for shallow well. /Depth to groundwater in this area has not been fully characterized.	Determine stratigraphy/depth to ground water from test borings.
	Characterize the shallow hydrogeologic unit. /The shallow hydrogeologic unit has not been characterized for this specific location.	Locate one well in the CBU Drum Storage Area and utilize proposed well 4MW1S as an upgradient well.
	Supplement existing information in order to further define ground water flow direction and estimate gradients. /Ground water flow has not been fully characterized for this specific site.	Perform ground water elevation measurements prior to each round of sampling. Collect data to prepare a base-wide ground water elevation map.
Chemical Investigation Soils	Confirm lack of surface soil contamination; collect health risk data. /Surface soil quality has not been adequately characterized.	Collect and analyze surface soil samples from within the CBU Drum Storage Area. Plot or contour concentrations of chemicals of concern on site maps.
	Confirm lack of subsurface soil contamination. Characterize the chemical nature of fill materials within the Drum Storage Area; collect health risk data. /Subsurface sampling has not been conducted at the site.	Install a series of test borings, within the drum storage area. Collect and analyze a subsurface soil sample from each boring.
Ground Water	Determine ground water quality within drum storage area; collect health risk data. /Ground water quality has not been determined at this site.	Install a monitoring well within the drum storage area. Sample and analyze the ground water for constituents of concern.
	Evaluate potential temporal changes in ground water quality. /Ground water quality has not been determined at this site.	Perform two rounds of ground water sampling and analysis.
Engineering Investigation	No objectives have been defined as this is a Step I investigation.	None required.

TABLE 7-2
CBU - DRUM STORAGE AREA
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	VOCs were detected in previously collected surface soil samples.
SVOC[2]	●	SVOCs were detected in previously collected surface soil samples.
Inorganic[3]	●	Elevated lead concentrations were detected in previously collected surface soils.
Pesticides	●	The pesticide DDD was detected in a previously collected surface soil sample.
PCB[4]	●	Not detected in Step I Study, regardless PCB will be tested for as possibly waste materials stored in this area contained PCB.
TCLP[5]	●	Determine leaching potential of metals in soils.
Radiological[6]		Further ground water analyses are being performed at Area A.
Dioxin[7]		Historically, neither petroleum products nor chlorinated compounds have been burned at this site and dibenzofuran was not detected during the Step I investigation.
Engineering Characteristics[8]		Feasibility study data requirements not necessary at this time.

Notes:

1 VOC means volatile organic compound listed in the CLP TCL.
2 SVOC means semi-volatile organic compound listed in the CLP TCL.
3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5 TCLP means toxicity characteristic leaching procedures (Analysis to be performed for metals only).
6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).

TABLE 7-3
CBU DRUM STORAGE AREA FIELD SAMPLING PLAN

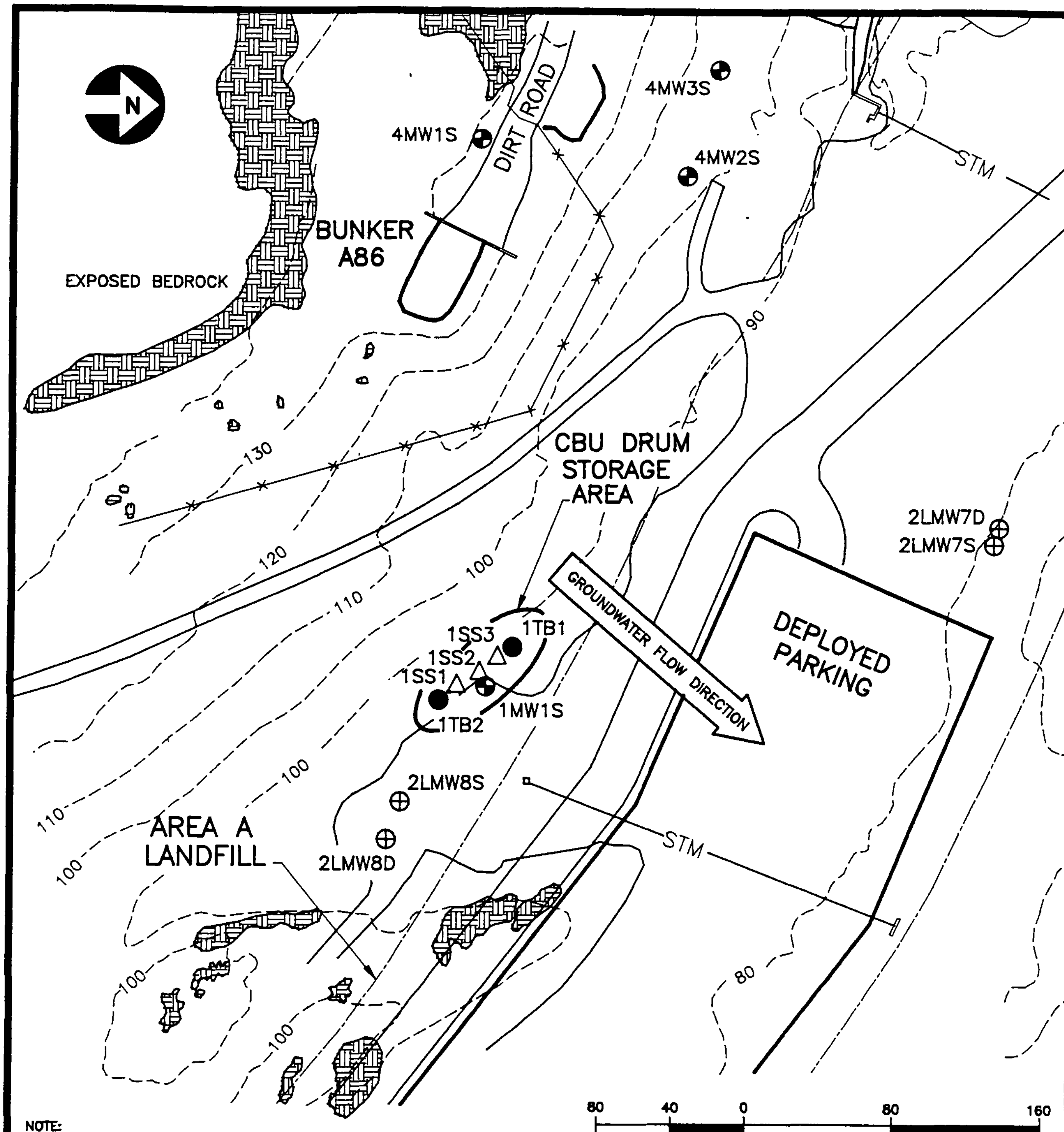
Sample Location	Well Depth/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type		Analysis							
				Soil	Water	VOC	SVOC	Inorganics	Pesticides	PCB	TPH	TCLP[2]	Engineering
Monitoring Well													
1MW1S	Overburden/20±	Monitor quality of ground water and test for subsurface soil contamination within the CBU Drum Storage Area.	1MW1S (0-2')	●		●	●	●	●	●	●	●	
			1MW1S (depth)	●		●	●	●	●	●	●	●	
			1GW1S		●	●	●	●	●	●	●		
Test Borings													
1TB1	NA/15'	Further evaluate potential subsurface soil contamination.	1TB1 (0-2')	●		●	●	●	●	●	●		
			1TB1 (depth)	●		●	●	●	●	●	●		
1TB2	NA/15'	Further evaluate potential subsurface soil contamination.	1TB2 (0-2')	●		●	●	●	●	●	●		
			1TB2 (depth)	●		●	●	●	●	●	●		
			Total Soils	**6**		**6**	**6**	**6**	**6**	**6**	**6**	**2**	**0**
			Total Water[1]		**2**	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**0**

PROPOSED

3 Test borings (including well boring)
1 Well

Notes:

[1] Total includes 2 sampling rounds.
[2] TCLP metals only.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

EXIST.	PROP.		
6MW1	7MW5	MONITORING WELL	
6TB1	7TB5	TEST BORING	
2DSD1	2DSD5	SEDIMENT SAMPLE	
6SS1	7SS5	SURFACE SOIL SAMPLE	
2DSW1	SDSW5	SURFACE WATER SAMPLE	
		—10—	EXIST CONTOUR
		123	BUILDING No.
			WATERCOURSE
		—STM—	STORM SEWER
			CATCH BASIN

FIGURE 7-1
FIELD SAMPLING PLAN
CBU DRUM STORAGE AREA

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- Collect data for a qualitative human health risk assessment.

The remedial investigation objectives and associated investigative actions are included in Table 7-4. The rationale for selection of constituents for analysis is provided in Table 7-5. Table 7-6 provides details of the field sampling plan including location, number and type of samples, location rationale, and analysis requirements.

Figure 7-2 illustrates the proposed sample locations.

The general approach to be used in this investigation is presented below. Preliminary investigations identified tetrachloroethene at a very low concentration. There were no other compounds identified at the site above background values. The supplemental Step I investigation is designed to further confirm that chemical contaminants are not present at levels of concern. The investigation will assess whether contamination has impacted deeper soils and ground water in the OBDANE area. The field program will consist of a series of soil borings, the installation of a monitoring well, and collection of soil (surface and subsurface) and ground water samples for chemical analysis.

Test borings will be drilled for geologic and chemical characterization of subsurface media and fill materials. The monitoring well will be installed to assess site ground water quality.

7.2 Step II Investigations

7.2.1 Rubble Fill at Bunker A-86

The specific goals of this investigation include the overall goals listed in Section 7.0 and the following:

- Determine the source, nature and extent of chlorinated solvents, arsenic, pesticides and PAH contamination in soil, ground water and surface water.

- Determine the extent of fill material based on visual observations.

- Collect human health risk assessment data.

- Characterize site geology, including depth to bedrock.

- Define ground water hydrology.

The remedial action objectives and associated investigative actions are included in Table 7-7. The rationale for selection of constituents for analysis is provided in Table 7-8. Table 7-9 provides details of the field sampling plan including location, number and type of samples, location rationale, and analysis requirements.

Figure 7-3 illustrates the proposed sample locations.

TABLE 7-4
OVER BANK DISPOSAL AREA NORTHEAST (OBDANE)
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geologic features. /Geologic features have not been completely mapped.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevations.
Geologic Investigation	Characterize stratigraphy of overburden. Characterize the physical nature of fill materials in the OBDANE Area. /No information regarding stratigraphy of overburden has been collected in this area.	Perform a series of test borings; collect continuous core samples.
Hydrogeologic Investigation	Determine appropriate screen interval for shallow well. /Depth to ground water has not been determined.	Determine stratigraphy/depth to ground water from test borings.
	Characterize the shallow hydrogeologic unit. /The shallow hydrogeologic unit has not been characterized for this specific location.	Locate one well in the OBDANE Area and utilize existing well in the area as upgradient well.
	Supplement existing information in order to further define ground water flow direction and estimate gradients. /Ground water flow direction information for this area has not been measured at this site.	Perform ground water elevation measurements prior to each round of sampling. Collect data to prepare a base-wide ground water elevation map.
Chemical Investigation Soils	Confirm lack of surface soil contamination; collect health risk data. /Surface soil quality has not been fully characterized.	Collect and analyze surface soil samples from within the OBDANE area. Plot or contour concentrations of chemicals of concern on site maps.
	Confirm lack of subsurface contamination. Characterize the chemical nature of fill materials within the OBDANE area; collect health risk data. /Subsurface soil sampling has not been conducted at this site.	Install a series of test borings, within the OBDANE area. Collect and analyze a subsurface soil sample from each boring.
Ground Water	Determine ground water quality within OBDANE Area; collect health risk data. /Ground water quality has not been determined at this site.	Install a monitoring well within the OBDANE area. Sample and analyze the ground water for constituents of concern.
	Evaluate potential temporal changes in ground water quality. /Ground water quality has not been determined at this site.	Perform two rounds of ground water sampling and analysis.
Engineering Investigation	No objectives have been identified as this is a Step I investigation.	None required.

TABLE 7-5
OBDANE AREA
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Tetrachloroethene was detected in a previously collected surface soil sample.
SVOC[2]	●	Included for completeness.
Inorganic[3]	●	Included for completeness.
Pesticides		Not detected in Step I Investigation.
PCB[4]		Not detected in Step I Investigation.
TCLP[5]	●	Determine leaching potential of metals in soils.
Radiological[6]		Further ground water analysis are being performed at Area A.
Dioxin[7]		Historically, neither petroleum products nor chlorinated compounds have been burned at this site and dibenzofuran was not detected during the Step I investigation.
Engineering Characteristics[8]		Feasibility study data requirements not necessary at this time.

Notes:

1 VOC means volatile organic compound listed in the CLP TCL.
2 SVOC means semi-volatile organic compound listed in the CLP TCL.
3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5 TCLP means toxicity characteristic leaching procedures (analysis to be performed for metals only).
6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).

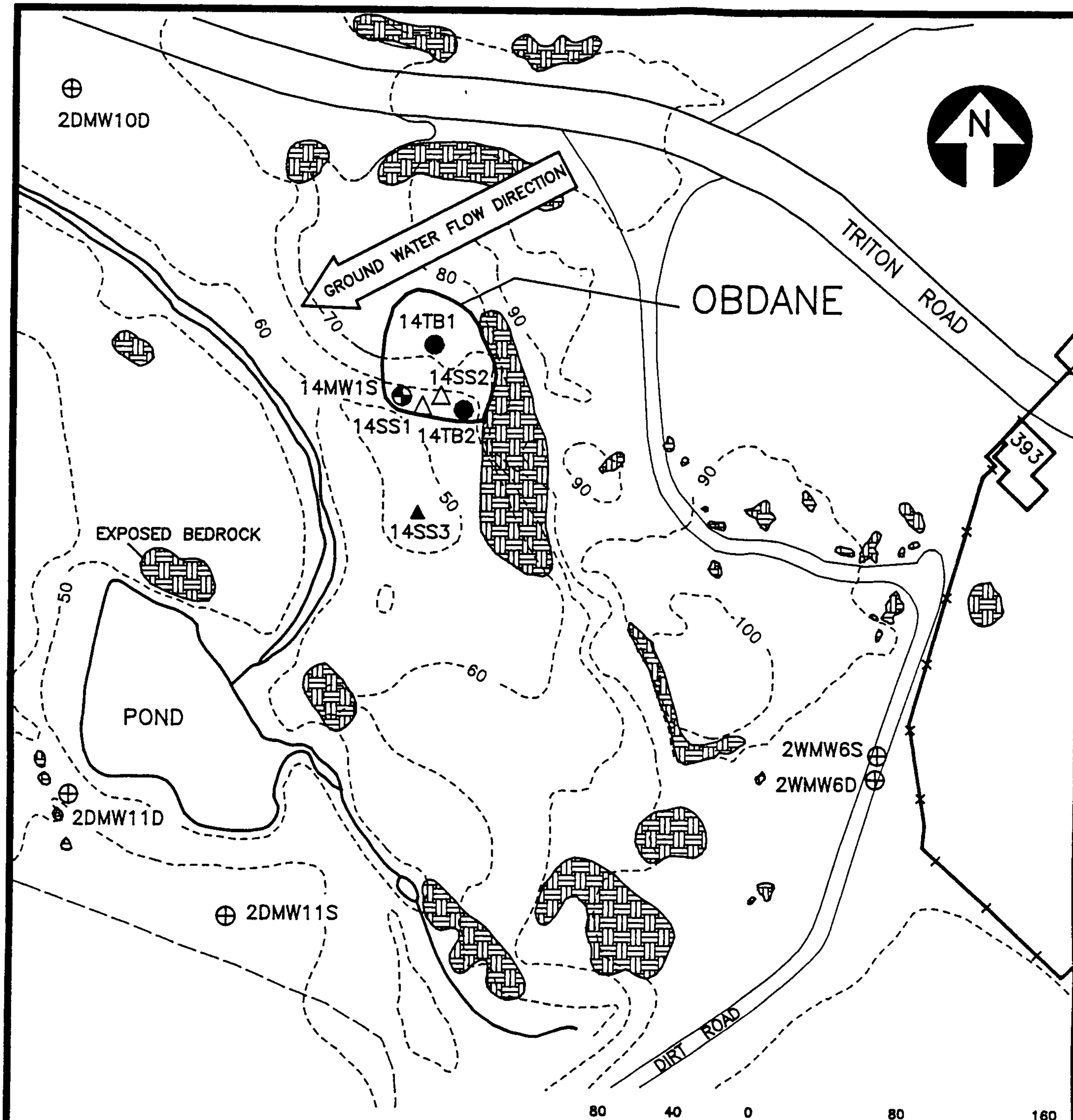
TABLE 7-6
OBDANE FIELD SAMPLING PLAN

Sample Location	Well Depth/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type: Soil	Sample Type: Water	Analysis: VOC	Analysis: SVOC	Analysis: Inorganics	Analysis: Pesticides	Analysis: PCB	Analysis: TCLP[2]	Analysis: Engineering
			Monitoring Well									
14MW1S	Overburden/20±	Monitor quality of ground water and test for subsurface soil contamination within the OBDANE area.	14MW1S (0-2')	●		●	●	●			●	
			14MW1S (depth)	●		●	●	●			●	
			14GW1S		●	●	●	●				
			Test Borings									
14TB1	NA/15'	Further evaluate potential subsurface soil contamination.	14TB1 (0-2')	●		●	●	●				
			14TB1 (depth)	●		●	●	●				
14TB2	NA/15'	Further evaluate potential subsurface soil contamination.	14TB2 (0-2')	●		●	●	●				
			14TB2 (depth)	●		●	●	●				
			Sediment Samples									
14SS3	0-6"	To determine if contaminants have accumulated in low spot downgradient of OBDANE.	14SS3 (0-6")	●		●	●	●	●			
			Total Soils	**7**		**7**	**7**	**7**	**1**	**0**	**2**	**0**
			Total Water[1]		**2**	**2**	**2**	**2**	**0**	**0**	**0**	**0**

PROPOSED

3 Test borings (including well boring)
1 Well

Notes:
[1] Total includes 2 sampling rounds.
[2] TCLP metals only.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

LEGEND

EXIST.	PROP.	
6MW1	7MW5	MONITORING WELL
6TB1	7TB5	TEST BORING
2DSD1	2DSD5	SEDIMENT SAMPLE
6SS1	7SS5	SURFACE SOIL SAMPLE
2DSW1	SDSW5	SURFACE WATER SAMPLE

---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—	STORM SEWER
	CATCH BASIN

FIGURE 7-2
FIELD SAMPLING PLAN
OBDANE

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TABLE 7-7
RUBBLE FILL AT BUNKER A-86
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geologic features. /Proposed sample locations and some geologic features have not been located.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevations.
Geologic Investigation	Characterize stratigraphy of overburden and depth to bedrock. Characterize the physical nature of fill materials in the rubble fill area. /No site-specific information regarding stratigraphy at the site exists.	Perform a series of test borings; collect continuous core samples. Core 5 feet into bedrock at 4MW4D.
Hydrogeologic Investigation	Determine appropriate screen interval for shallow wells. /No site-specific information regarding depth to ground water at the site exists.	Determine stratigraphy/depth to ground water from test borings.
	Characterize the shallow hydrogeologic unit. /No specific site-specific information exists regarding ground water flow direction at the site.	Locate monitoring wells up- and downgradient of rubble fill area.
	Further define ground water flow direction and estimate gradients. /No site-specific information exists regarding ground water flow direction at the site.	Perform ground water elevation measurements prior to each round of sampling. Collect data to prepare a base-wide ground water elevation map.
	Determine ground water flow rates. /No site-specific information exists regarding ground water flow rates at the site.	Perform hydraulic conductivity tests on one well (4MW2).
Chemical Investigation Soils	Determine nature and extent of surface soil contamination, particularly with regard to arsenic; health risk data. /Only limited information regarding surface soil contamination has been collected at the site. The extent of arsenic contamination has not been determined.	Collect and analyze series of surface soil samples around rubble fill area. Plot or contour concentrations of chemicals of concern on site maps.
	Determine nature, extent, and degree of subsurface soils contamination, particularly PAH contaminants. Characterize the chemical nature of fill materials within the rubble fill area; health risk data. /No subsurface soil information has been collected at the site.	Install a series of test borings, one in center of rubble fill area, and others downgradient. Collect and analyze a subsurface soil sample from each boring.
Ground Water	Determine nature, extent, and degree of ground water contamination; health risk data. /No ground water analytical information exists at the site.	Install monitoring wells to determine extent of contaminant plume, if any. Sample and analyze all wells for constituents of concern.
	Identify upgradient ground water quality. /No ground water analytical information exists at the site.	Sample and analyze upgradient well for constituents of concern.

TABLE 7-7 (Continued)
RUBBLE FILL AT BUNKER A-86
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
	Evaluate potential temporal changes in ground water quality. /No ground water analytical information exists at the site.	Perform two rounds of ground water sampling and analysis.
Surface Water and Sediment	Evaluate surface water and sediment chemical quality in nearby surface drainage. Determine if contaminants are being transported offsite by these mechanisms. /No information exists regarding sediment and surface water quality at the site.	Sample and analyze surface water and sediment from one location upgradient and one location downgradient of fill area.
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil and ground water samples for specified engineering characteristic parameters.

TABLE 7-8
RUBBLE FILL AT BUNKER A-86
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Chlorinated solvents were detected in two previous surface soil samples. Study area not adequately characterized for this parameter.
SVOC[2]	●	Detected in composite surface soil sample. Study area not adequately characterized for this parameter.
Inorganics[3]	●	High arsenic concentration detected in composite surface soil sample. Study area not adequately characterized for this parameter.
Pesticides	●	Pesticides (BHC and methoxychlor) detected in composite surface soil sample. Study area not adequately characterized for this parameter.
PCB[4]	●	Study area not adequately characterized for this parameter.
TCLP[5]	●	Determine hazardous characteristics for selected samples.
Radiological Analyses[6]		Further ground water analyses are being performed at Area A.
Dioxin[7]		Historically, neither petroleum products nor chlorinated compounds have been burned at this site and dibenzofuran was not detected during Step I investigations.
Engineering Characteristics[8]	●	Feasibility study data requirements for select samples.

Notes:

1 VOC means volatile organic compound listed in the CLP TCL.
2 SVOC means semi-volatile organic compound listed in the CLP TCL.
3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5 TCLP means toxicity characteristic leaching procedures.
6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).

TABLE 7-9
RUBBLE FILL AT BUNKER A-86 FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth	Rationale	Sample Designations	Sample Type: Soil	Sample Type: Water	Analysis: VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	Engineering
Monitoring Wells												
4MW1S[1]	Overburden/20±' (Bedrock well installed if no overburden aquifer)	Monitor quality of shallow ground water and test for subsurface soil contamination upgradient of Rubble Fill area.	4MW1S (0-1')	•		•	•	•	•	•		
			4GW1S		•	•	•	•	•	•		
4MW2S[1]	Overburden/20±' (Bedrock well installed if no overburden aquifer)	Monitor quality of shallow ground water and test for subsurface soil contamination downgradient of Rubble Fill area.	4MW2S (depth)	•		•	•	•	•	•		•
			4GW2S		•	•	•	•	•	•		
4MW3S[1]	Overburden/20±' (Bedrock well installed if no overburden aquifer)	Monitor quality of shallow ground water and test for subsurface soil contamination downgradient, northwest of Rubble Fill area.	4MW3S (depth)	•		•	•	•	•	•		•
			4GW3S		•	•	•	•	•	•		•
4MW4S[1]	Overburden/20±'	Monitor quality of shallow ground water and test for subsurface soil contamination downgradient, northwest of Rubble Fill area.	4MW4S (depth)	•		•	•	•	•	•		
			4GW4S		•	•	•	•	•	•		
4MW4D[1]	Bedrock	Monitor quality of deep ground water and test for subsurface soil contamination downgradient, northwest of Rubble Fill area.	4GW4D		•	•	•	•	•	•		
Test Borings												
4TB1	NA/Bedrock (20±')	Determine stratigraphy/nature of fill material in center of Rubble Fill area. Determine nature and extent of subsurface soil contamination in potential source area.	4TB1 (depth)	•		•	•	•	•	•	•	
4TB2	NA/Bedrock (20±')	Further define extent of subsurface soil contamination northeast of Rubble Fill area.	4TB2 (depth)	•		•	•	•	•	•	•	
4TB3	NA/Bedrock (20±')	Further define extent of subsurface soil contamination northeast of Rubble Fill area.	4TB3 (0-1')	•		•	•	•	•	•		
			Subtotal Soil	7		7	7	7	7	7	2	2
			Subtotal Water/1 Sampling Round		5	5	5	5	5	5	0	1
Surface Soil Sampling												
4SS4	Surficial	Determine nature and extent of surface soil contamination downgradient of Rubble Fill area.	4SS4 (0-6")	•		•	•	•	•	•		
4SS5	Surficial	Further define extent of surface soil contamination downgradient of Rubble Fill area.	4SS5 (0-6")	•		•	•	•	•	•		
4SS6	Surficial	Assess surface soil quality in Rubble Fill area.	4SS6 (0-6")	•		•	•	•	•	•		

TABLE 7-9 (continued)
RUBBLE FILL AT BUNKER A-86 FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth	Rationale	Sample Designations	Sample Type: Soil	Sample Type: Water	Analysis: VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	Engi-neering
4SS7	Surficial	Determine nature and extent of surface soil contamination east of Rubble Fill area west of Bunker.	4SS7 (0-6")	●		●	●	●	●	●		
4SS8	Surficial (0-1')	Determine nature and extent of surface soil contamination northwest of Rubble Fill area.	4SS8 (0-6")	●		●	●	●	●	●		
4SS9	Surficial	Assess surface soil quality in Rubble Fill area.	4SS9 (0-6')	●		●	●	●	●	●		
4SS10	Surficial	Assess surface soil quality in Rubble Fill area.	4SS10 (0-6")	●		●	●	●	●	●		
			Subtotal Surface Soils	7		7	7	7	7	7	0	0
Surface Water/Sediment Sampling												
4SW1/SD1	-	Generate chemical data for surface water and sediments from surface drainage upgradient of Rubble Fill area to determine contaminant loading.	4SW1		●	●	●	●	●	●		
			4SD1	●		●	●	●	●	●		●
4SW2	-	Upgradient of wetland at stormwater outlet that passes by Rubble Fill at Bunker A-86.	4SW2		●	●	●	●	●	●		
4SD2[2]	-	Generate chemical data for sediment in surface drainage downgradient of Rubble Fill area to determine whether site contaminants are being transported offsite by this mechanism.	4SD2	●		●	●	●	●	●		●
			Subtotal Sediments	2		2	2	2	2	2	0	2
			Subtotal Surface Water		2	2	2	2	2	2	0	0
			Total Soils	**16**		**16**	**16**	**16**	**16**	**16**	**2**	**4**
			Total Water[2]		**12**	**12**	**12**	**12**	**12**	**12**	**0**	**1**

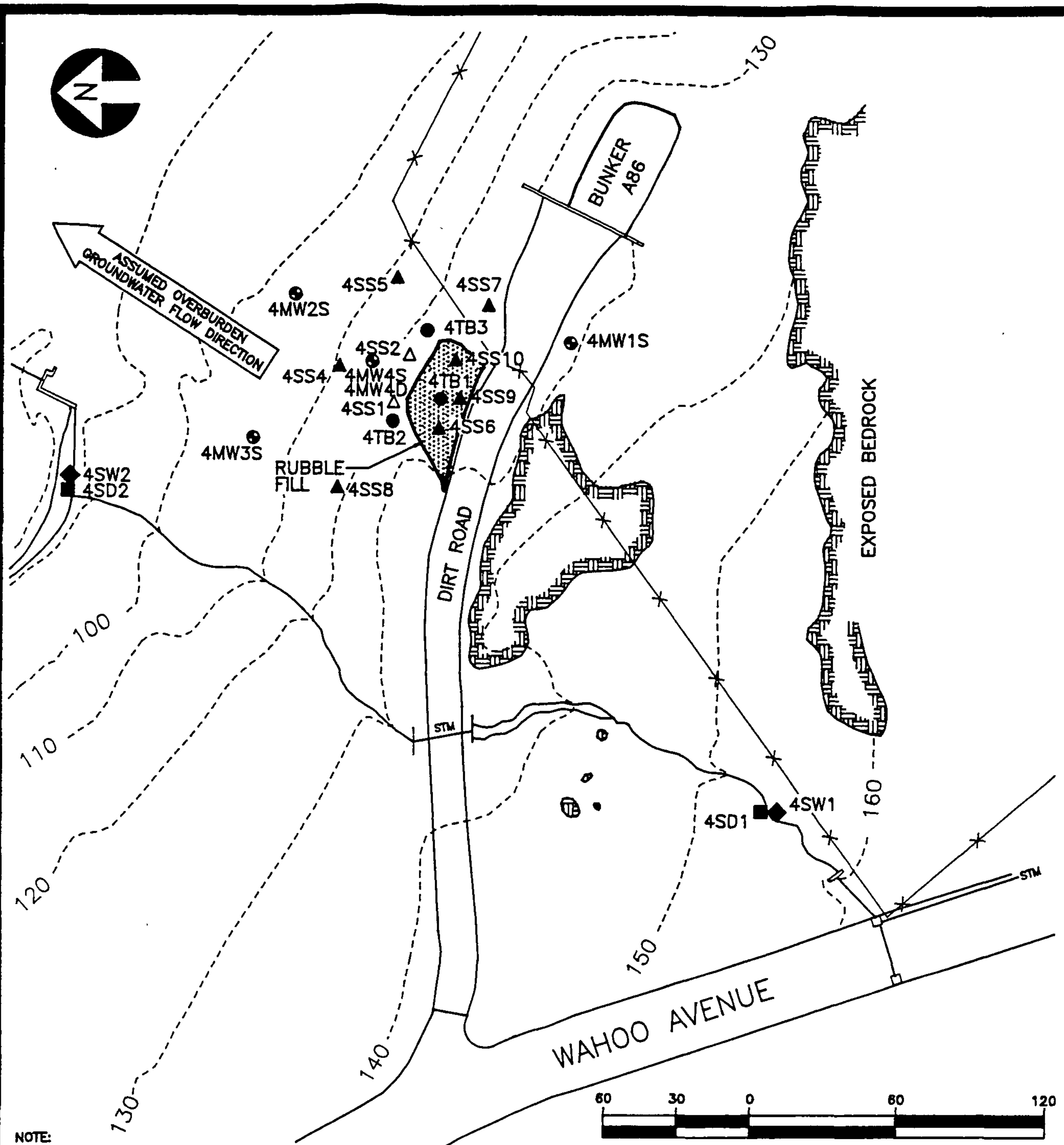
PROPOSED

6 Test borings (including well borings)
3 Wells

Notes:

[1] If a bedrock well is required, it will be installed into the first significant water bearing unit and to a minimum depth of 20 feet or whichever is greater.

[2] Total includes two sampling rounds.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

EXIST.	PROP.	
6MW1	7MW5	MONITORING WELL
6TB1	7TB5	TEST BORING
6SD1	7SD5	SEDIMENT SAMPLE
6SS1	7SS5	SURFACE SOIL SAMPLE
6SW1	7SW5	SURFACE WATER SAMPLE

---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
---STM---	STORM SEWER
	CATCH BASIN

FIGURE 7-3
FIELD SAMPLING PLAN
RUBBLE FILL AT BUNKER A86

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The general approach to be used in this investigation is presented below. Preliminary investigations identified trace concentrations of VOCs and low to moderate levels of PAH compounds, arsenic, and pesticides in surface soil samples collected immediately downgradient of the rubble fill area. Of particular concern from a health risk perspective is the arsenic detected in surficial soils. The Step II investigation is designed to assess whether contamination has impacted deeper soils and ground water in the vicinity, assess the extent of surface soil contamination, and assess whether surficial contaminants are being carried offsite in surface water runoff. The field program will consist of a series of soil borings, installation of monitoring wells, and collection of soil (surface and subsurface), surface water, ground water, and sediment samples for chemical analysis. The investigation will focus on the rubble fill area and immediate vicinity and attempt to delineate the vertical and lateral extent of any contamination associated with it. The extent of fill will be determined by visual observations, and its depth will be determined by a soil boring. Test borings will be drilled for geologic and chemical characterization of subsurface media and fill materials. The monitoring wells (overburden and/or bedrock, depending upon proximity of the uppermost water-bearing unit) will be installed to assess site ground water quality and evaluate site ground water hydrology.

7.2.2 Torpedo Shops

The site investigation's specific goals include the overall goals listed in Section 7.0 and the following:

- Determine the source, nature and extent of VOC and antimony contamination in soil, ground water, sediments and surface water.
- Determine the extent of Otto fuel leakage.
- Collect human health risk assessment data.
- Further define site geology and hydrology.

The remedial action objectives and associated investigative actions are included in Table 7-10. The rationale for selection of constituents for analysis is provided in Table 7-11. Table 7-12 provides details of the field sampling plan including location, number and type of samples; location rationale; and analysis requirements.

Figure 7-4 illustrates the proposed sample locations.

The general approach to be used in this investigation is described below. Actual placement of wells and borings relies on first performing soil gas and geologic surveys to identify potential areas of contamination and potential preferential ground water flow in the bedrock. Boring and/or well locations will be relocated to any locations where the soil gas survey identifies any area of moderate to high contamination and where potential preferential flow zones are identified in the bedrock. It is assumed that source areas of contamination will contain VOCs based on the detection of these substances in ground water during the Phase I RI. The focus of this investigation is principally around the Torpedo Shops, which are upgradient of the area evaluated during the Step I investigation (former subsurface sewage disposal

TABLE 7-10
TORPEDO SHOPS
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geological features.	Use existing site survey maps and draft site maps using AutoCAD®. Survey sample locations and elevation.
Geologic Investigation	Further define bedrock surface. Locate geologic contact and identify formation. /Geologic contact has not been accurately located, and depth to bedrock information is not complete around the buildings.	View stereo pairs of the site to map lineaments. Survey bedrock outcrops and measure strike and dip of bedrock fractures. Place a boring at the probable location of bedrock geologic formation contact and obtain core samples at locations 7TB7 and 7MW3D.
Hydrogeologic Investigation	Determine selection of screen settings in both shallow and deep wells. /Stratigraphy has not been fully characterized in the areas surrounding the buildings at the site.	Determine stratigraphy from test borings.
	Further identify and characterize hydrogeologic units. /Hydrogeologic information has not been collected from areas around the perimeter of the site or around the present buildings.	Place monitoring wells and borings at site perimeter and near probable source areas.
	Further define direction and gradients of ground water flow and determine hydraulic conductivity. /Precise ground water flow direction has not been determined for the entire site. Hydraulic conductivity has not been fully characterized at the site.	Measure water levels from new and existing wells and perform single well hydraulic conductivity tests (7MW7S, 7MW7D). Collect data to prepare a base-wide ground water elevation map.
Chemical Investigation Soils	Determine source of VOC and antimony contamination and further evaluate the nature and extent of contamination; health risk data. /Exact source of previously detected VOC and antimony contamination has not been determined.	Perform a soil gas survey around Torpedo Shops Buildings and in areas of former storage tanks and drum storage. Based upon the results of this survey and a knowledge of existing and historical chemical handling procedures, install test borings. Samples to be selected for laboratory analysis will be based upon field screening tests. If contamination is detected based upon field screening, additional borings will be installed as necessary to determine extent of soil contamination. Plot or contour concentrations of chemicals of concern on site maps.
	Determine extent and degree of soil contamination from waste Otto fuel tank and associated plumbing; health risk data. /Extent and degree of contamination due to waste Otto fuel tank has not been determined.	
	Determine extent and degree of soil contamination from former underground storage tank; health risk data. /No previous data has been collected regarding former underground storage tank.	
Ground Water	Further evaluate the nature and extent of ground water contamination; collect additional risk assessment data. /Contaminant plume has not been fully characterized.	Install monitoring wells in aquifers of concern; design monitoring well network to determine the extent of the plume; wells will also be located in downgradient area to confirm that the leading edge of the plume is located; collect and analyze samples.

TABLE 7-10 (Continued)
TORPEDO SHOPS
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
	Identify upgradient water quality for each geologic unit. /Shallow upgradient water quality information was not characterized previously.	Install upgradient monitoring wells in aquifers of concern and collect and analyze samples.
	Determine source of ground water contamination. /Contaminant sources were not determined with regard to ground water contamination.	Collect and analyze ground water samples and compare results to expected waste characteristics and background levels.
	Determine whether seasonal fluctuations occur in contaminant concentrations in the ground water and in hydraulic characteristics. /Seasonal fluctuation of contaminants has not been previously investigated.	Sample and analyze ground water; two rounds of sampling.
Surface Water and Sediment	Further define surface water and sediment chemical quality. /Data regarding surface water and sediments chemical quality at the site is limited.	Collect and compare up- and downgradient sediment samples. Sample surface water during a storm event.
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil and ground water samples for specified engineering characteristic parameters.

TABLE 7-11
TORPEDO SHOPS
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Detected in ground water and soils during Step I. Constituents of onsite chemicals/materials and potentially present in petroleum products.
SVOC[2]	●	Detected in soils during Step I and potentially present in petroleum products.
Inorganics[3]	●	Detected in soils during Step I and potentially present in petroleum products.
Pesticides	●	Detected in soils during Step I but not ground water. Not included in proposed ground water analysis.
PCB[4]	●	Detected in soils during Step I but not ground water. Not included in proposed ground water analysis.
TCLP[5]	●	Determine hazardous waste characteristics for selected samples.
Radiological Analyses[6]		Radiological contamination not suspected.
Dioxins[7]		Historically, neither petroleum products nor chlorinated solvent have been burned at this site and dibenzofuran was not detected during the Step I investigation.
Engineering Characteristics[8]	●	Feasibility study data requirements for select samples.
TPH[9]	●	Useful in assessing petroleum contamination.

Notes:

1. VOC means volatile organic compound listed in the CLP TCL.
2. SVOC means semi-volatile organic compound listed in the CLP TCL.
3. Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4. PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5. TCLP means toxicity characteristic leaching procedures.
6. Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7. Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8. Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).
9. TPH means total petroleum hydrocarbons.

TABLE 7-12
TORPEDO SHOPS FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type (No. of Samples)		Analysis							
				Soil	Water	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	TPH	Engi-neering
			Monitoring Wells										
7MW1D	Bedrock/25'	Existing	7GW1D		•	•	•	•					
7MW2S	Overburden/15±'	Existing	7GW2S		•	•	•	•					
7MW2D	Bedrock/20' (minimum penetration of bedrock)	Monitor quality of deep (bedrock) aquifer downgradient of north system leach field.	7GW2D		•	•	•	•					•
7MW3S	Overburden/15±'	Existing	7GW3S		•	•	•	•					
7MW3D	Bedrock/20' (minimum penetration of bedrock)	Monitor quality of deep (bedrock) aquifer downgradient of south system leaching field.	7GW3D		•	•	•	•					•
7MW4S	Overburden/25±'	Monitor quality of shallow ground water in area of paint shop and test for soil contamination upgradient of Building 325.	7GW4S		•	•	•	•					
			7MW4S (depth)	•		•	•	•	•	•			•
7MW5S	Overburden/25±'	Provide chemical data for shallow ground water and soils downgradient and near the former underground Otto fuel tank.	7GW5S		•	•	•	•					•
			7MW5S (depth)	•		•	•	•	•	•			•
7MW5D	Bedrock/20' (minimum penetration of bedrock)	Monitor quality of deep ground water in area of former Otto fuel tank.	7GW5D		•	•	•	•					•
7MW6S	Overburden/25±'	Provide chemical data for shallow ground water in and soils near and downgradient of Building 325.	7GW6S		•	•	•	•					
			7MW6S (depth)	•		•	•	•	•	•			
7MW7S	Overburden/25±'	Provide chemical data for shallow ground water in between both buildings and provide essential hydrogeologic data in center of site.	7GW7S		•	•	•	•					
			7MW7S (depth)	•		•	•	•	•	•			•
7MW8S	Overburden/25±'	In former tank grave.	7GW8S		•	•	•	•				•[1]	
			7MW8S (water table)	•		•	•	•	•	•	•	•[1]	•
7MW9S	Overburden/25±'	Downgradient of former tank.	7GW9S		•	•	•	•				•	
			7MW9S (water table)	•		•	•	•				•	
7MW10S	Overburden/25±'	Downgradient of former tank.	7GW10S		•	•	•	•				•	
			7MW10S (water table)	•		•	•	•				•	
			Test Borings										
7TB7	NA/Bedrock (25±')	Determine stratigraphy and nature of fill. Provide chemical characteristics of soils upgradient of north system. At location of bedrock formation contact.	7TB7 (depth)	•		•	•	•	•	•			
7TB8	NA/Bedrock (25±')	Determine stratigraphy and nature of fill in "back door" area of site.	7TB8 (depth)	•		•	•	•	•	•			

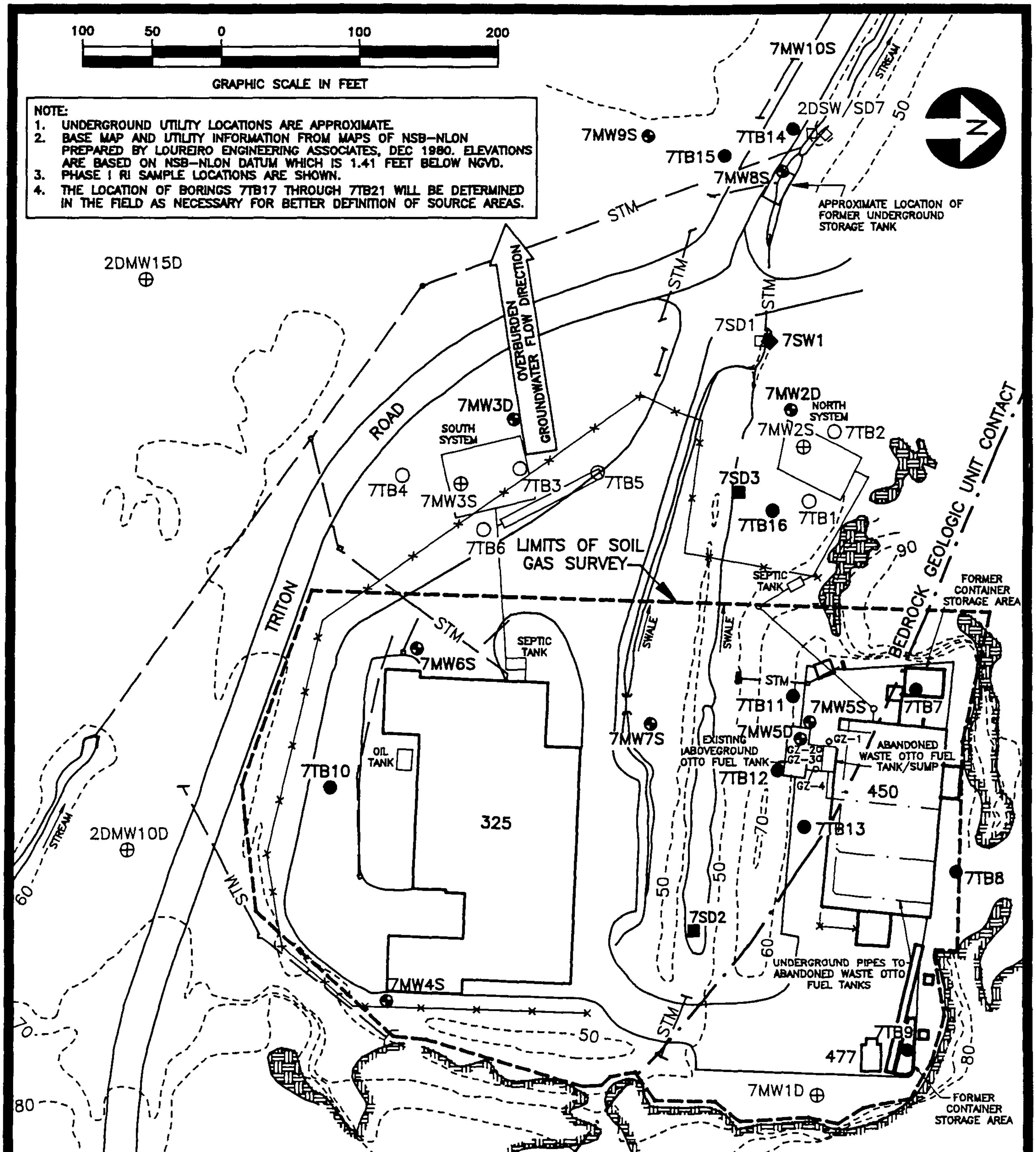
TABLE 7-12 (continued)
TORPEDO SHOPS FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type (No. of Samples)		Analysis							
				Soil	Water	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	TPH	Engi-neering
7TB9	NA/Bedrock (25±')	Determine stratigraphy and nature of fill in former drum storage area. Provide chemical data to determine if possible chemical release occurred in area.	7TB9 (depth)	•		•	•	•	•	•			
7TB10	NA/Bedrock (25±')	Determine stratigraphy and nature of fill south of Building 325. Chemically characterize soils.	7TB10 (depth)	•		•	•	•	•	•			
7TB11-7TB13	NA/Bedrock (25±')	Determine stratigraphy and nature of fill in area of abandoned underground Otto fuel tank. Evaluate extent of soil contamination.	7TB11 (depth)-7TB13 (depth)	• (3)		• (3)	• (3)	• (3)	• (3)	• (3)		• (3)	•
7TB14	NA/Bedrock (25±')	Downgradient of former tank.	7TB14 (water table)	•		•	•	•				•	
7TB15	NA/Bedrock (25±')	Downgradient of former tank.	7TB15 (water table)	•		•	•	•				•	
7TB16	NA/Bedrock (25±')	At sample point SG21 with high soil gas measurement.	7TB16 (depth)	•		•	•	•	•	•			
7TB17-7TB21	NA/Bedrock (25±')	Optional borings to be installed to determine the extent of soil contamination, if detected, based upon the field screening results.	7TB17 (depth) - 7TB21 (depth)	• (5)		• (5)	• (5)	• (5)				• (5)	• (5)
			Subtotal Soil	22		22	22	22	13	13	1	14	10
			Subtotal Water[2]		13	13	13	13	0	0	0	5	4
Sediment and Surface Water Sampling													
7SD2 7SD3 7SW1	NA	Provide chemical data for sediments both in up- and downgradient locations. Surface water sample is upgradient of Area A Downstream and downgradient of this site.	7SD2 and 7SD3	• (2)		• (2)	• (2)	• (2)	• (2)	• (2)			• (2)
			7SW1		•	•	•	•	•	•			
			Subtotal Soils	2		2	2	2	2	2	0	0	2
			Subtotal Surface Water		1	1	1	1	1	1	0	0	0
			Total Soils	**24**		**24**	**24**	**24**	**15**	**15**	**1**	**14**	**12**
			Total Water[3]		**27**	**27**	**27**	**27**	**1**	**1**	**0**	**10**	**8**

PROPOSED

20 Primary test borings (including well borings)
5 Supplemental test borings
10 Wells
- 3 Bedrock
- 7 Overburden

Notes:
[1] Sample also to be analyzed for oil type by fluorescence analysis.
[2] One round of sampling.
[3] Total includes two monitoring well sampling rounds.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

LEGEND

EXIST.	PROP.	
⊕ 6MW1	7MW5	MONITORING WELL
○ 6TB1	● 7TB5	TEST BORING
□ 2DSD1	■ 2DSD5	SEDIMENT SAMPLE
△ 6SS1	▲ 7SS5	SURFACE SOIL SAMPLE
◇ 2DSW1	◆ 2DSW5	SURFACE WATER SAMPLE
○ GZ-1		WELL BY OTHERS

---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—	STORM SEWER
	CATCH BASIN

FIGURE 7-4
FIELD SAMPLING PLAN
TORPEDO SHOPS

ATLANTIC ENVIRONMENTAL SERVICES, INC.

systems). The field investigation is also based on previous chemical management activities at this site. Test borings will be drilled and soil samples collected for analysis near known and potential contaminant sources such as the abandoned waste Otto fuel tank, the former underground storage tank near the guard house, and areas where chemicals have been stored. Field screening techniques will be used to aid in selection of samples to be analyzed and in determining whether or not to install additional borings to better resolve the extent of contamination. A series of overburden and bedrock wells will be used to assess ground water quality and further evaluate site ground water hydrology.

7.2.3 Goss Cove

The site investigation's specific goals include the overall goals listed in Section 7.0 and the following:

- Further define the extent of lead, VOCs and SVOCs, pesticides and PCBs contamination in soil and ground water.
- Determine if dioxin exists in subsurface soils.
- Measure indoor air quality for risk assessment.
- Measure methane in soil gas and during installation of wells 6MW6S and 6P to determine if methane gas is present above levels of concern.
- Collect additional human health risk and ecological risk assessment data.
- Further define site geology and hydrology.
- Confirm that radiological constituents in ground water are from natural sources.

The remedial action objectives and associated investigative actions are included in Table 7-13. The rationale for selection of constituents for analysis is provided in Table 7-14. Table 7-15 provides details of the field sampling plan including location, number and type of samples; location rationale; and analysis requirements.

Figure 7-5 illustrates the proposed sample locations.

A general overview of this investigation is described below. The wells and borings are located to define further the nature and extent of contamination detected during the Step I investigation; locations are approximate as utility conflicts may warrant slight relocation. Subsurface soils may contain any or all of the following: VOCs, SVOCs, inorganics, pesticides and PCBs, based on the detection of these substances in soils and ground water during the Step I investigation. Field screening techniques will be used to aid in the decision to install additional supplemental resolution borings if required. Soil samples will be collected at discrete intervals based on visual and field screening observations. Samples for engineering analysis will be selected to be from the screened interval of a monitoring well or in areas that may require

TABLE 7-13
GOSS COVE LANDFILL
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geologic features. Measure strike and dip of bedrock fractures on exposed bedrock outcrop. /Information regarding bedrock fractures has not been extensively studied.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevation.
Geologic Investigation	Better define stratigraphy below the landfill material and determine depths to bedrock. /Depth to bedrock has not been adequately determined.	Install select borings and monitoring wells to bedrock. Core 5 feet into bedrock at location 8TB9 and 8MW8D.
Hydrogeologic Investigation	Determine hydraulic conductivity of the different units below the site. /Hydraulic conductivity has not been determined for the deep bedrock aquifer.	Install nested monitoring wells to identify the vertical head differences between the units. Also perform a single well hydraulic conductivity test on one nested well (8MW2S,8MW2D).
	Determine if there is temporal fluctuation of ground water elevations. /Temporal fluctuation of ground water elevations has not been previously investigated at the site.	Measure ground water elevations prior to each round of sampling at low tide.
	Better define ground water flow directions. /The southern portion of site previously not investigated.	Evaluate ground water flow direction based on each round of water levels collected. Collect data to prepare a base-wide ground water elevation map.
Chemical Investigation Soils	Assess the potential for dioxins at the site. /Not previously analyzed for.	Sample soils in areas where dibenzofurans have previously been detected, especially ash samples.
	Further determine the nature, extent and degree of soil contamination within the Landfill; collect additional health risk assessment data. /Extent and degree of soil contamination not completely characterized previously.	Collect and analyze soil samples from proposed borings. Plot or contour concentrations of chemicals of concern on site maps.
Surface Water and Sediments	Determine presence or absence of chemical contamination of surface water and sediments in Goss Cove; for use in ecological and health risk assessment. /Cove sediments and surface water has not been previously analyzed.	Perform sediment sampling and surface water sampling in Goss Cove.
Air	Assess potential migration of VOCs to interior of Nautilus Memorial; health risk data. /Indoor air sampling not previously analyzed.	Collect air samples from the basement (boiler room) and the museum area (ground floor), as well as a background air sample from outside the building.
Ground Water	Determine the source of radiological constituents (natural or anthropogenic) detected in ground water. /Source of elevated radiological constituents in ground water has not been independently verified.	Perform radiological analysis (gross alpha/beta and gamma spectrum analysis) of ground water from wells with previous elevated levels of alpha and beta radiation (8MW1S, 8MW4S).

TABLE 7-13 (Continued)
GOSS COVE LANDFILL
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
	Evaluate potential temporal changes in ground water quality; collect additional health and ecological risk assessment data. /Temporal changes in ground water quality not previously addressed.	Perform two rounds of ground water sampling.
	Determine if a downward migration of contamination has occurred at the site. /Deep ground water not previously sampled at the site.	Analyze ground water from both deep and shallow wells at the site.
	Determine upgradient ground water quality. /Deep ground water quality not adequately characterized upgradient of the site.	Sample and analyze ground water from upgradient monitoring wells (8MW8S, 8MW8D).
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study elevation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil and ground water samples for specified engineering characteristic parameters.

TABLE 7-14
GOSS COVE LANDFILL
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Detected in subsurface soil and water samples collected during Step I.
SVOC[2]	●	Detected in subsurface soil samples collected during Step I.
Inorganics[3]	●	Detected in subsurface soil samples collected during Step I.
Pesticides	●	Detected in subsurface soil samples collected during Step I, but not ground water. Not included in proposed ground water analysis.
PCB[4]	●	Detected in subsurface soil and water samples collected during Step I, but not ground water. Not included in proposed ground water analysis.
TCLP[5]	●	Determine hazardous waste characteristics for selected samples.
Radiological Analyses[6]	●	Detected in ground water collected during Step I above screening values.
Dioxins[7]	●	Determine the possible presence of dioxins in areas previously identified as having dibenzofuran contamination.
Engineering Characteristics[8]	●	Feasibility study data requirements for select samples.

Notes:

1 VOC means volatile organic compound listed in the CLP TCL.

2 SVOC means semi-volatile organic compound listed in the CLP TCL.

3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.

4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.

5 TCLP means toxicity characteristic leaching procedures.

6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.

7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.

8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).

TABLE 7-15
GOSS COVE LANDFILL FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type			Analysis								
				Soil	Water	Air	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	RAD[4]	Dioxin	Engi-neering
Monitoring Wells															
8MW1	Existing	Existing	8GW1		•		•	•	•				•		
8MW2S	Existing	Existing	8GW2S		•		•	•	•						
8MW2D	Overburden/100±'	Located adjacent to area of high soil gas concentrations. Evaluates water quality at interval above bedrock surface; health and ecological risk data.	8MW2D (0-1)	•			•	•	•	•	•	•			•
			8MW2D (depth)	•			•	•	•	•	•				•
			8GW2D		•		•	•	•						
8MW3	Existing	Existing	8GW3		•		•	•	•						
8MW4	Existing	Existing	8GW4		•		•	•	•				•		
8MW5S	Overburden/15±'	Previous investigation indicates highest inorganic concentrations in soil at the site are at 8TB1; 8MW5 will provide additional soil data. Also provides additional hydrogeologic and ground water quality information; health and ecological risk data.	8GW5S		•		•	•	•						
			8MW5S (depth)	•			•	•	•	•	•	•			•
8MW6S	Overburden/15±'	Provide chemical data for soils and ground water directly adjacent to the Nautilus Museum Building; health risk and ecological risk data.	8MW6S (0-1)	•			•	•	•	•	•				
8MW6D	Overburden/100±'		8GW6S		•		•	•	•						
			8MW6S (depth)	•			•	•	•	•	•	•			•
			8MW6D (depth)	•			•	•	•	•	•				•
			8GW6D		•		•	•	•						
8MW7S	Overburden/15±'	Provide chemical data for soils and ground water in an area adjacent to moderate soil gas concentrations. Also provide additional hydrogeologic and water quality information near Goss Cove; health and ecological risk data.	8MW7S (0-1)	•			•	•	•	•	•				
			8GW7S		•		•	•	•						
			8MW7S (depth)	•			•	•	•	•	•	•			•
8MW8S	Overburden/top of bedrock (30±')	Upgradient background well to provide background water quality values for the site.	8GW8S		•		•	•	•						•
			8MW8S (depth)	•			•	•	•	•	•				•
8MW8D[1]	Bedrock/50±'	Upgradient background well to provide background water quality values for the site.	8MW8D (depth)	•			•	•	•	•	•				•
			8GW8D		•		•	•	•						

TABLE 7-15 (continued)
GOSS COVE FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type			Analysis								
				Soil	Water	Air	VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	RAD[4]	Dioxin	Engineering
			Test Borings												
8TB4	NA/Base of fill (20±')	Provide chemical characteristics of soils located in an area of moderate soil gas concentrations. Also provide stratigraphy and depth to bedrock information.	8TB4 (0-1)	•			•	•	•	•	•				
			8TB4 (depth)	•			•	•	•	•	•	•			
8TB5	NA/Base of fill (20±')	Near area of elevated PAH and area of moderate soil gas concentrations.	8TB5 (depth)	•			•	•	•	•	•	•		•	
8TB6	NA/Base of fill (20±')	Near area of elevated PAHs found in 8TB2 and 8TB3 soils.	8TB6 (0-1)	•			•	•	•	•	•				
			8TB6 (depth)	•			•	•	•	•	•	•		•	
8TB7	NA/Base of fill (20±')	Provide data regarding the extent of landfill material; chemical characteristics.	8TB7 (depth)	•			•	•	•	•	•				
8TB8	NA/Base of fill (20±')	Provide chemical data in area of high soil gas concentrations.	8TB8 (0-1)	•			•	•	•	•	•				
			8TB8 (depth)	•			•	•	•	•	•	•			
8TB9	NA/Base of fill (20±')	Provide data regarding the extent of landfill material; chemical characteristics.	8TB9 (depth)	•			•	•	•	•	•	•			
8TB10	NA/Base of fill (20±')	Provide data regarding the extent of landfill material; chemical characteristics.	8TB10 (depth)	•			•	•	•	•	•				
8TB11-15	NA/Base of fill (20±')	Optional borings to be installed to determine extent of soil contamination, if required, based upon the field screening results.	8TB11-15 (depth)	• (5)			• (5)	• (5)	• (5)	• (5)	• (5)				
			Subtotal Soil	25	0		25	25	25	25	25	9	0	2	8
			Subtotal Ground Water[2]	0	11		11	11	11	0	0	0	2	0	1
			Surface Water/Sediment Sampling												
8SW2	Surface water	Provide chemical data for surface water and sediments in Goss Cove; near shore of landfill.	8SW2		•		•	•	•	•	•				•
8SD2	Sediment		8SD2	•			•	•	•	•	•				•
8SW3	Surface water	Provide additional data for the surface water and sediments in Goss Cove; near shore of landfill.	8SW3		•		•	•	•	•	•				•
8SD3	Sediment		8SD3	•			•	•	•	•	•	•			•

TABLE 7-15 (continued)
GOSS COVE FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type			Analysis								
				Soil	Water	Air	VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	RAD[4]	Dioxin	Engineering
8SW4	Surface water	Provide chemical data for surface water and sediments in Goss Cove area near shore of landfill.	8SW4		●		●	●	●	●	●				●
8SD4	Sediment		8SD4	●			●	●	●	●	●				●
8SW5	Surface water	Provide chemical data for surface water and sediments in Goss Cove away from the immediate influence of landfill material.	8SW5		●		●	●	●	●	●				●
8SD5	Sediment		8SD5	●			●	●	●	●	●				●
8SW6	Surface water	Provide chemical data for surface water and sediments in Goss Cove away from the immediate influence of landfill material.	8SW6		●		●	●	●	●	●				●
8SD6	Sediment		8SD6	●			●	●	●	●	●				●
			Subtotal Sediments	5	0	0	5	5	5	5	5	1	0	0	5
			Subtotal Surface Water	0	5	0	5	5	5	5	5	0	0	0	5
Air Sampling															
8AS1	Air/Tenax tube	Located in basement of building in the boiler room where contaminants are likely to enter the building through foundation walls.	8AS1			●	●								
8AS2	Air/Tenax tube	Located in main exhibition room where workers and visitors are likely to be exposed for the longest duration.	8AS2			●	●								
8AS3	Air/Tenax tube	Outside building to represent background conditions at the site.	8AS3			●	●								
			Subtotal Air/Round	0	0	3	3	0	0	0	0	0	0	0	0
			Total Soils[3]	30	0	0	30	30	30	30	30	10	0	2	13
			Total Water[3]		27		27	27	27	5	5	0	4	0	7
			Total Air[3]			6	6								

PROPOSED

14 Primary test borings (including well borings)
5 Supplemental test borings
7 Wells
- 1 Bedrock
- 4 Shallow overburden
- 2 Deep overburden

Notes:

[1] Bedrock well will be installed into first significant water bearing unit and to a minimum depth of 20 feet.
[2] One round of ground water sampling.
[3] Total includes two rounds of sampling.
[4] RAD means gamma spectrum analysis and gross alpha/beta analysis.

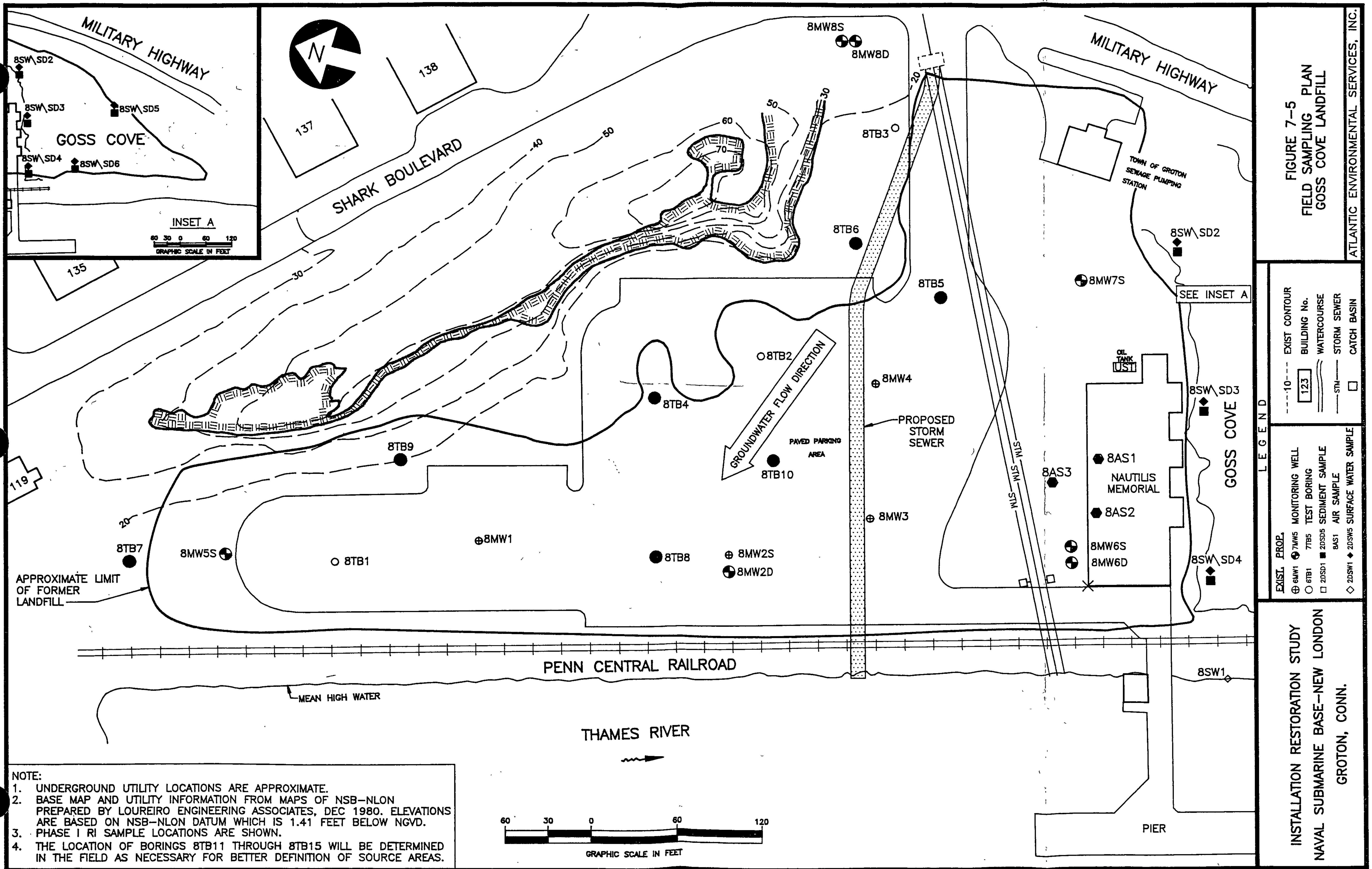


FIGURE 7–5
FIELD SAMPLING PLAN
GOSS COVE LANDFILL
ATLANTIC ENVIRONMENTAL SERVICES, INC.
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.
LEGEND
---10--- EXIST CONTOUR
123 BUILDING No.
WATERCOURSE
STM STORM SEWER
CATCH BASIN
EXIST. PROP.
6MW1 7MW5 MONITORING WELL
6TB1 7TB5 TEST BORING
2DSD1 2DSD5 SEDIMENT SAMPLE
8AS1 AIR SAMPLE
2DSW1 2DSW5 SURFACE WATER SAMPLE
MILITARY HIGHWAY
SHARK BOULEVARD
GOSS COVE
INSET A
GRAPHIC SCALE IN FEET
8SW\SD2
8SW\SD3
8SW\SD4
8SW\SD5
8SW\SD6
N
137
138
135
119
8MW8S
8MW8D
8TB3
8TB6
8TB5
8MW7S
TOWN OF GROTON SEWAGE PUMPING STATION
SEE INSET A
OIL TANK
UST
8TB2
8MW4
8TB4
GROUNDWATER FLOW DIRECTION
PROPOSED STORM SEWER
PAVED PARKING AREA
8TB9
8TB10
8AS1
8AS3
NAUTILIS MEMORIAL
8AS2
8MW3
8MW1
8TB7
8MW5S
8TB1
8TB8
8MW2S
8MW2D
8MW6S
8MW6D
STM
APPROXIMATE LIMIT OF FORMER LANDFILL
PENN CENTRAL RAILROAD
8SW1
MEAN HIGH WATER
THAMES RIVER
PIER
NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB–NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB–NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
4. THE LOCATION OF BORINGS 8TB11 THROUGH 8TB15 WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF SOURCE AREAS.
60 30 0 60 120
GRAPHIC SCALE IN FEET

remediation. Near surface (0-1') samples will also be collected for the risk assessment. The collected soil, ground water, and indoor air sampling at the museum will allow a quantitative health risk assessment to be performed at this site. In addition to human health risks, ecological risk assessment of Goss Cove and the Thames River will be conducted. Surface water and sediment sampling of Goss Cove is included. Thames River investigations are discussed in detail in Section 5.0 of this Work Plan. Sample locations specified in Section 5.0 include a transect of sediment samples (T3SD1, T4SD1, T5SD1) starting along the bank of the Thames River north and upstream of the pier, yet south and downstream of the storm drain outfall from the ball fields. These sample locations are shown in Figure 5-3 and described in Table 5-2. Proposed additional ground water investigation will provide water quality information to be used in the ecological risk assessment.

7.2.4 Spent Acid Storage and Disposal Area

The specific goals of this investigation include the overall goals listed in Section 7.0 and the following:

- Determine the nature and extent of lead, VOC and SVOC contamination in soil and ground water.
- Determine the extent of contaminated soils which may be classified as hazardous on the basis of TCLP analysis.
- Collect human health risk assessment data.
- Further define site geology and hydrology.

The remedial action objectives and associated investigative actions are included in Table 7-16. The rationale for selection of constituents for analysis is provided in Table 7-17. Table 7-18 provides details of the field sampling plan including location, number and type of samples; location rationale; and analysis requirements.

Figure 7-6 illustrates the proposed sample locations.

The general approach to be used in this investigation is presented below. Preliminary investigations at this site identified low levels of VOCs and PAHs, and elevated levels of lead in subsurface soils in the vicinity of the former acid storage tank. The Step II investigation is designed to determine the extent of soil contamination associated with past spent acid management activities, and whether contamination has impacted local ground water. The field program will consist of a series of soil borings, installation of monitoring wells, and collection of soil (surface and subsurface), ground water, and sediment samples for chemical analysis. The investigation will focus on the vicinity of the spent acid tank, with boring and soil sampling progressing outward from the tank to define the extent of contamination. Test borings will be drilled for geologic and chemical characterization of subsurface media and fill materials. Field screening of continuous core samples using X-ray fluorescence methods will facilitate delineation of lead contamination and selection of appropriate soil samples for chemical analysis. A series

TABLE 7-16
SPENT ACID STORAGE AND DISPOSAL AREA
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geologic features.	Use existing site survey maps and draft site maps using AutoCAD®. Survey sample locations and elevations.
Geologic Investigation	Further characterize the stratigraphy of overburden and depth to bedrock. /Depth to bedrock has not been determined at this site.	Perform a series of test borings; collect continuous core samples; complete two test borings to bedrock. Core 5 feet into bedrock at 15MW2S.
Hydrogeologic Investigation	Determine appropriate screen interval for shallow well(s). /Accurate ground water elevation has not been determined at the site.	Determine stratigraphy/depth to ground water from test borings.
	Characterize hydrogeologic unit. /Ground water monitoring wells were not previously installed at the site.	Locate monitoring wells up- and downgradient of source area.
	Further define ground water direction and estimate gradient. /No ground water elevation or direction data exists for the site.	Perform ground water elevation measurements prior to each round of sampling. Collect data to prepare a base-wide ground water elevation map.
	Determine ground water flow rates. /Hydraulic conductivity tests have not been previously performed.	Perform hydraulic conductivity tests on wells 15MW1S and 15MW3S.
Chemical Investigation Soils	Confirm source of soil contamination, particularly lead. Determine nature, extent, and degree of subsurface soil contamination; collect additional risk assessment data. /Nature, extent, and degree of soil contamination not adequately characterized.	Install a series of test borings. Collect a soil sample from each boring for laboratory analysis. Samples will be selected on the basis of field screening tests (X-ray fluorescence for lead). Borings will be installed in a radial sequence away from the former acid tank; supplemental borings will be installed as necessary to determine extent of soil lead contamination. Plot or contour concentrations of concern on site maps.
Ground Water	Determine nature, extent, and degree of ground water contamination; collect health risk assessment data. /Nature, extent, and degree of ground water contamination has not been previously investigated.	Install monitoring wells to determine extent of contaminant plume, if any. Sample all wells for constituents of concern.
	Identify upgradient ground water quality. /Ground water monitoring wells were not previously installed at the site.	Sample and analyze water sample from upgradient monitoring well.
	Evaluate potential temporal changes in ground water quality. /No ground water quality data exists for the site.	Perform two rounds of ground water sampling analysis.

TABLE 7-16 (Continued)
SPENT ACID STORAGE AND DISPOSAL AREA
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Sediments	Evaluate contaminant concentrations in nearby stormwater drainage system sediments. Determine if contaminants are being transported offsite. /Offsite transport of contamination has not been previously investigated with respect to the storm water drainage system.	Sample and analyze sediment sample from stormwater manhole serving study area system.
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil and ground water samples for specified engineering characteristic parameters.

TABLE 7-17
SPENT ACID STORAGE AND DISPOSAL AREA
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Detected in one soil sample during Step I. Study area not adequately characterized for this parameter.
SVOC[2]	●	Detected in one soil sample during Step I. Study area not adequately characterized for this parameter.
Inorganics[3]	●	Detected in one soil sample during Step I. Heavy metals (especially lead) are significant constituents of spent battery acid.
Pesticides	●	Study area not adequately characterized for this parameter during Step I.
PCB[4]	●	Study area not adequately characterized for this parameter during Step I.
TCLP[5]	●	Determine hazardous characteristics for selected samples. Four previous soil samples from study area failed TCLP for lead.
Dioxin[6]		Historically, neither petroleum products nor chlorinated compounds have been burned at this site and dibenzofuran was not detected during Step I investigations.
Engineering Characteristics[7]	●	Feasibility Study data requirements for select samples.

Notes:

1. VOC means volatile organic compound listed in the CLP TCL.
2. SVOC means semi-volatile organic compound listed in the CLP TCL.
3. Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4. PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5. TCLP means toxicity characteristic leaching procedures.
6. Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7. Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8. Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).

TABLE 7-18
SPENT ACID STORAGE AND DISPOSAL AREA FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type		Analysis						
				Soil	Water	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	Engi-neering
Monitoring Wells												
15MW1S	Overburden/20±' (advance to bedrock)	Provide chemical data for shallow and deep ground water and subsurface soils in source area, immediately downgradient of the former acid storage tank; determine depth to bedrock.	15MW1S (depth)	●		●	●	●	●	●	●	●
15MW1D	Bedrock/50±'		15GW1S		●	●	●	●	●	●		●
15MW2S	Overburden/20±'	Monitor quality of shallow ground water and test for soil contamination upgradient of the former acid storage tank.	15MW2S (depth)	●		●	●	●	●	●		
			15GW2S		●	●	●	●	●	●		
15MW3S	Overburden/20±'	Monitor quality of shallow ground water and subsurface soils downgradient of the former acid storage tank.	15MW3S (depth)	●		●	●	●	●	●		
			15GW3S		●	●	●	●	●	●		
15MW4S	Overburden/20±' (advance to bedrock)	Monitor quality of shallow ground water and subsurface soils downgradient of the former acid storage tank; determine depth to bedrock.	15MW4S (depth)	●		●	●	●	●	●		
			15GW4S		●	●	●	●	●	●		
Test Borings												
15TB4	NA/15±'	Determine stratigraphy/nature of fill immediately north of the former acid storage tank. Further determine nature, extent and degree of soil contamination.	15TB4 (depth)	●		●	●	●	●	●	●	●
15TB5	NA/15±'	Further define extent of subsurface soil contamination (within 35' southeast of former acid tank).	15TB5 (depth)	●		●	●	●	●	●	●	
15TB6	NA/15±'	Further define extent of subsurface soil contamination (within 35' west of former acid tank).	15TB6 (depth)	●		●	●	●	●	●	●	
15TB7	NA/15±'	Further define extent of subsurface soil contamination (within 50' south of former acid tank).	15TB7 (depth)	●		●	●	●	●	●		
15TB8	NA/15±'	Further define extent of subsurface soil contamination (within 50' northwest of former acid tank).	15TB8 (depth)	●		●	●	●	●	●		
15TB9	NA/15±'	Determine nature and extent of subsurface soil contamination within 50' east of former acid tank.	15TB9 (depth)	●		●	●	●	●	●		
15TB10-15TB14	NA/15±'	Optional borings to be installed to determine extent of soil contamination, if required, based on the field screening results.	15TB10 (depth)-15TB14 (depth)	● (5)		● (5)	● (5)	● (5)	● (5)	● (5)		
			Subtotal Soils	15	0	15	15	15	15	15	4[1]	2
			Subtotal Water[2]	0	4	4	4	4	4	4	0	1

TABLE 7-18 (continued)
SPENT ACID STORAGE AND DISPOSAL AREA FIELD SAMPLING PLAN

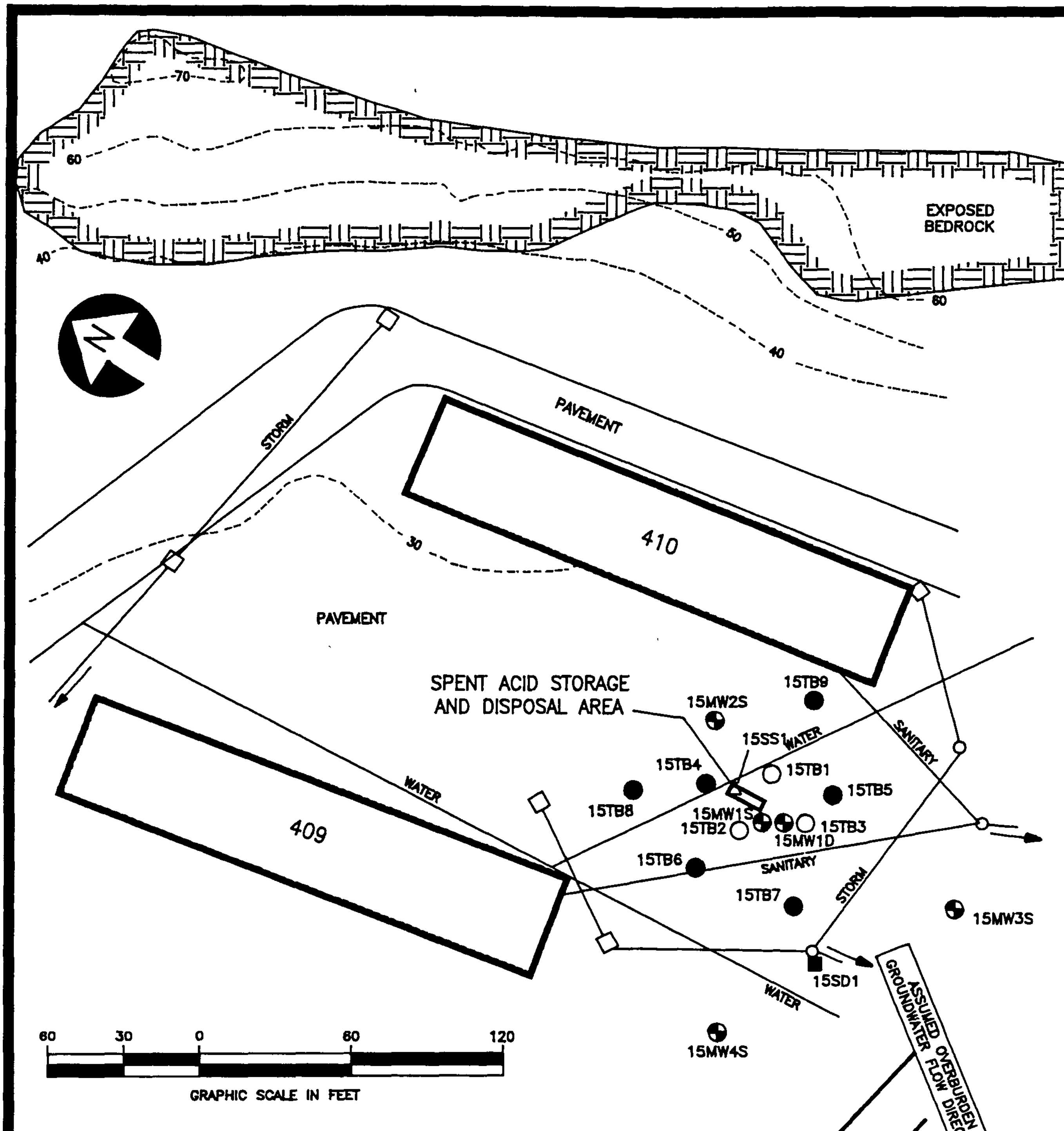
Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type		Analysis						
				Soil	Water	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	Engi-neering
Sediment Sampling												
15SD1	-	Provide chemical data for sediment from downgradient, stormwater location to determine whether site contaminants are being transported offsite by these mechanisms.	15SD1	•		•	•	•	•	•		•
			Subtotal Sediments	1	0	1	1	1	1	1	0	1
			Total Soils	**16**	**0**	**16**	**16**	**16**	**16**	**16**	**4[1]**	**3**
			Total Water[3]	**0**	**8**	**8**	**8**	**8**	**8**	**8**	**0**	**2**

PROPOSED

10 Primary test borings (including well borings)
5 Supplemental test borings
4 Wells

Notes:

[1] Four TCLP inorganic analyses will be conducted based on field screening for lead; one of the four will be selected for full TCLP analysis.
[2] Total includes 1 round of sampling only.
[3] Total includes 2 rounds of sampling.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
4. THE LOCATION OF BORINGS 15TB10 THROUGH 15TB14 WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF SOURCE AREAS.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

LEGEND

EXIST.	PROP.	
⊕ 15MW1	15MW1	MONITORING WELL
○ 15TB1	● 15TB1	TEST BORING
□ 15SD1	■ 15SD1	SEDIMENT SAMPLE
△ 15SS1	▲ 15SS1	SURFACE SOIL SAMPLE
◇ 15SW1	◆ 15SW1	SURFACE WATER SAMPLE

---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
○	MANHOLE
□	CATCH BASIN

FIGURE 7–6
FIELD SAMPLING PLAN
SPENT ACID STORAGE AND DISPOSAL AREA

ATLANTIC ENVIRONMENTAL SERVICES, INC.

of monitoring wells will be installed to assess site ground water quality and evaluate site ground water hydrology.

7.3 Supplemental Step II Investigations

7.3.1 Area A

The site investigation's specific goals of the investigation are summarized below; the goals address the recommendations of the Phase I RI report and Technical Review Committee comments. General investigation tasks are provided for each goal.

- Define extent of contamination detected near and in concrete pad (former chemical storage area) located at the west end of the Area A Landfill.
  - test borings, coring of the pad, and soil pad material analysis will be conducted
- Confirm that elevated levels of pesticides are not present in the Area A Wetland.
  - sediment samples will be collected and analyzed
- Expand study area to include Weapons Center.
  - soil, ground water and sediment analysis will be conducted
- Further define extent of pesticide contamination in surface soil and sediment in Area A Downstream.
  - surface soil and sediment sampling and analysis will be conducted.
- Further assess ground water flow direction and hydraulic gradients, particularly at southeast end of landfill near NSB-NLON east gate.
  - additional overburden and bedrock monitoring wells will be installed, samples analyzed and water levels measured monthly at select locations; ground water flow directions will be determined
- Define the extent of VOC and cadmium ground water contamination downgradient of the Area A Landfill.
  - additional overburden and bedrock monitoring wells will be installed and samples analyzed; ground water flow directions will be determined
- Further evaluate surface water quality (DDTR, metals, VOC) to determine if surface water remediation is appropriate and required.

- a surface water sampling and analysis program will be undertaken

- Further evaluate potential ecological risks in Area A Downstream, primarily associated with elevated levels of pesticides.

  - the ecological assessment is discussed in Section 5.0

- Update human health risk assessment based on additional collected data.

  - the human health risk assessment is discussed in Section 4.0

- Evaluate the feasibility of pump-and-treat ground water remediation at the Area A Landfill.

  - a ground water pump test will be conducted in the Area A Landfill

- Determine if detectable concentrations of chlorinated dioxins exist in subsurface soils.

  - collect soil samples from locations where dibenzofurans were previously detected or from ash material

- Confirm that radiological constituents detected in ground water are from natural sources.

  - resample wells where radiological constituents previously exceeded action levels

- Define wetland boundaries within Area A.

  - perform wetlands delineation

The remedial investigation objectives and associated investigative actions are included in Table 7-19. The rationale for selection of constituents for analysis is provided in Table 7-20. Table 7-21 provides details of the field sampling plan including location, number and type of samples; location rationale; and analysis requirements.

Figures 7-7 and 7-8 illustrate the proposed sample locations.

7.3.2 DRMO

The specific goals of the investigation are summarized below; the goals address the recommendations of the Phase I RI report and Technical Review Committee comments. General investigation tasks are provided for each goal.

TABLE 7-19
AREA A
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives	Action
	Area A	
Site Mapping	Map proposed sample locations and other geologic features.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevations.
Geological Investigation	Identify possible pathways for ground water movement. /A fracture trace study has not been previously performed at the site.	Examination of aerial photographs for geologic structures (e.g., lineaments). Field measurements of geologic structures (e.g., joints, faults) at bedrock outcrops. Core 5 feet into bedrock at locations 2WMW21D, 2WMW22D, 2DMW24D, and 2DMW27D.
	Area A Landfill	
Hydrogeologic Investigation	Further assessment of the ground water flow direction between the southeast portion of Area A landfill and homes serviced by private wells near NSB-NLON East Gate. /The possibility of offsite migration to private wells located off base has not been fully investigated.	Install monitoring wells and measure water levels from select wells on a monthly basis for one year; residential wells as specified in Field Sampling Plan.
	Evaluate the feasibility of ground water extraction related to potential treatment. /An aquifer pump test has not been previously performed at the site.	Conduct aquifer pump tests; includes installing a pilot test well and piezometers, pumping the well at a constant rate, and measuring the changes in water level in piezometers located at different distances from the pilot well.
Chemical Investigation Ground Water	Obtain additional analytical data on ground water quality; collect additional health and ecological risk data. /Ground water quality at the southernmost portion of the site has not been evaluated.	Conduct two ground water sampling and analysis rounds from proposed and existing wells (second sampling round will be conducted three months after the first round).
	Determine the source of radiological constituents (natural or anthropogenic) detected in ground water. /Source of elevated radiological constituents in ground water has not been independently verified.	Collect ground water from monitoring wells in areas previously found to have gross alpha levels equal or greater than 5 pci/L and/or gross beta levels equal or greater than 50 pci/L, and perform specific radiological analysis (gamma spectrum, gross alpha/beta).
Subsurface Soil	Define lateral and vertical extent and degree of soil contamination identified around Area A concrete pad (former hazardous waste storage area); collect additional health risk data. /Lateral and vertical extent and degree of soil contamination associated with the concrete pad has not been determined.	Collect and analyze subsurface soil from proposed borings. Each soil sample will be field screened for volatile organic compounds and PCBs. Selected samples will be collected for laboratory analysis.
	Determine if detectable concentrations of chlorinated dioxins exist in subsurface soils; collect additional health and ecological risk data. /Dioxin analysis was not previously performed at the site.	Collect and analyze subsurface soil collected from areas where dibenzofurans and/or ash have been detected.

TABLE 7-19 (continued)
AREA A
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives	Action
Engineering Investigation Ground Water	Determine levels of conventional pollutants in ground water. /Levels of conventional pollutants have not been determined previously at the site.	Analyze samples collected during pumping of the overburden aquifer.
Subsurface Soil	Determine engineering characteristics of soils from underlying geologic units. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze representative samples for engineering parameters.
	Area A Wetlands	
Hydrogeologic Investigation	Further define ground water flow directions and calculate hydraulic gradients; determine whether seasonal or temporal fluctuations occur in ground water flow directions. /The possibility of offsite migration to private wells located off base has not been fully investigated.	Install monitoring wells and measure water levels from select proposed and existing wells on a monthly basis for one year; residential wells as specified in Field Sampling Plan.
Chemical Investigation Ground Water	Obtain additional analytical data on ground water quality; collect additional health and ecological risk data.	Conduct two ground water sampling and analysis rounds from existing and proposed wells (second sampling round will be conducted three months after the first round).
	Determine the source of radiological constituents (natural or anthropogenic) detected in ground water. /Source of elevated radiological constituents in ground water not adequately determined.	Collect ground water from monitoring wells in areas previously found to have gross alpha levels equal or greater than 5 pci/L and/or gross beta levels equal or greater than 50 pci/L, and perform specific radiological isotope analysis.
Surface Water	Determine if there is an upgradient source for the constituents that have been detected in surface water above ARAR values and determine temporal variation in surface water quality. /Upgradient samples not previously collected and analyzed for contaminants. No previous sampling was performed during storm (high flow) events.	Collect another round of surface water samples during a storm event and add several additional upgradient sample locations.
Sediment	Confirm the relatively low concentrations of pesticides detected in wetland sediments and provide additional pesticide analytical data for comparison with Area A downstream sediments; collect additional health and ecological risk data. /Source of elevated pesticides detected in downstream sediments was not identified in the wetland area.	Collect and analyze sediment samples. Each sediment sample will be screened for pesticides in the field using a portable gas chromatograph. Selected samples will be collected for laboratory analysis.

TABLE 7-19 (continued)
AREA A
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives	Action
	Area A Downstream/OBDA	
Hydrogeologic Investigation	Further define ground water flow directions and calculate hydraulic gradients near North Lake; determine whether temporal fluctuations occur in ground water flow directions; determine extent of ground water contamination. /Temporal fluctuation of ground water has not been fully evaluated for this area.	Install monitoring wells and measure water levels from select wells on a monthly basis for one year; residential wells as specified in Field Sampling Plan.
Chemical Investigation Ground Water	Define lateral and vertical extent and degree of ground water contamination; collect additional health and ecological risk data. /Lateral and vertical extent and degree of ground water contamination has not been fully evaluated for this area.	Conduct two ground water sampling and analysis rounds from existing and proposed wells (second sampling round will be conducted three months after the first round).
	Determine the source of radiological constituents (natural or anthropogenic) detected in ground water; collect additional health and ecological risk data. /Source of elevated radiological constituents in ground water have not been independently verified.	Collect ground water from monitoring wells in areas previously found to have gross alpha levels equal or greater than 5 pci/L and/or gross beta levels equal or greater than 50 pci/L, and perform specific radiological analysis.
Surface Water	Continued monitoring of North Lake surface water quality.	Collect and analyze surface water samples from North Lake.
	Define concentrations of any chemical in surface water collected from areas where ground water seeps into North Lake.	Collect and analyze surface water samples from North Lake seeps (samples will be collected when the lake is drained preferably prior to filling in early spring or soon after draining in the fall).
	Determine if there is an upgradient source for the constituents that have been detected in surface water above ARAR values and determine temporal variation in surface water quality. /Upgradient samples not previously collected and analyzed for contaminants. No previous sampling was performed during storm (high flow) events.	Collect another round of surface water samples during a storm event and add several additional upgradient sample locations.
Surficial Soil	Further define extent of pesticide contamination identified in surficial soil samples from the Area A downstream watercourse; collect additional health and ecological risk data. /Extent of pesticide contamination has not been fully determined.	Collect and analyze surficial soil collected from hand augers. Each soil sample will be field screened for pesticides. Selected samples will be collected for laboratory analysis.
Sediments	Define concentrations of pesticides in sediments collected from areas where ground water seeps into North Lake and from Area A downstream ponds; collect additional health and ecological risk data. /North Lake sediments have not been tested during drained conditions fully.	Collect and analyze sediment samples from proposed sediment sample locations (samples will be collected during non-summer months and/or when the lake is drained). Each sediment sample (excluding North Lake) will be screened for pesticides in the field using a portable gas chromatograph. Selected samples will be collected for laboratory analysis.

TABLE 7-19 (continued)
AREA A
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives	Action
Quantitative Ecological Investigation	Delineate areas where contaminants in soil have demonstrable effects of soil organisms. /A quantitative ecological investigation has not been performed in this area.	Perform bioassays using introduced earthworms.
	Delineate areas where contaminants in sediment may have demonstrable effects on invertebrates. /A quantitative ecological investigation has not been performed in this area.	Perform bioassays using introduced earthworms.
	Define community parameters such as numerical density, numerically dominant species, species evenness, and number of species. /A quantitative ecological investigation has not been performed in this area.	Collect samples of benthic organisms and identify individuals to lowest taxonomic category practicable.
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil, sediment and ground water samples for specified engineering characteristic parameters.
	Weapons Center	
Hydrogeologic Investigation	Further define ground water flow directions and calculate hydraulic gradients; determine whether seasonal or temporal fluctuations occur in ground water flow directions. /Ground water flow direction has not been measured.	Install monitoring wells and measure water levels from select wells on a monthly basis for one year; residential wells as specified in Field Sampling Plan.
Chemical Investigation Ground Water	Determine source of elevated levels of cyanide and PAHs at Weapons Center and southeast of Weapons Center. /Source of previously detected PAHs and cyanide has not been determined.	Conduct two ground water sampling and analysis rounds from proposed and existing wells, and compare results to expected waste characteristics and background concentrations.
Subsurface Soil	Evaluate subsurface soil quality to assess potential source areas; collect additional health and ecological risk data. /Source areas of elevated PAHs and cyanide have not been determined.	Collect and analyze subsurface soil samples from proposed borings.
Sediments	Evaluate sediment chemical characteristics at site. /Sediment quality has not been fully characterized.	Collect and analyze sediment samples from proposed sediment sample locations.
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil, sediment and ground water samples for specified engineering characteristic parameters.

TABLE 7-20
AREA A
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Detected in soil, sediment, and water samples collected during Step I.
SVOC[2]	●	Detected in soil, sediment, and ground water samples collected during Step I.
Inorganics[3]	●	Detected in soil, sediment, and water samples collected during Step I.
Pesticides	●	Detected in sediments, surface water, and surface soil samples collected during Step I, but not detected in ground water. Not included in proposed ground water analysis.
PCB[4]	●	Detected in sediments and surface soil samples collected during Step I but not detected in surface or ground water except at one well location. Not included in proposed ground water analysis.
TCLP[5]	●	Determine hazardous waste characteristics for selected samples.
Radiological Analyses[6]	●	Alpha and beta radiation above screening levels detected in ground water samples collected during Step I.
Dioxins[7]	●	Dibenzofuran detected in soils and sediment samples collected during Step I.
Engineering Characteristics[8]	●	Feasibility study data requirements for select samples.

Notes:

1 VOC means volatile organic compound listed in the CLP TCL.
2 SVOC means semi-volatile organic compound listed in the CLP TCL.
3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5 TCLP means toxicity characteristic leaching procedures.
6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total). At this site, all sediment samples will be analyzed for TOC and grain size.

TABLE 7-21
AREA A FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type: Soil (No. of Samples)	Sample Type: Sediment (No. of Samples)	Sample Type: Water (No. of Samples)	Analysis: VOC	Analysis: SVOC	Analysis: Inorganics	Analysis: Pesticides	Analysis: PCB	Analysis: TCLP	Analysis: Dioxin	Analysis: RAD	Analysis: Engineering[4]
Monitoring Wells															
26 Existing wells	Existing	Sample all existing wells. Only well 2LMW18S analyzed for PCBs to confirm previous analysis.	Existing			• (26)	• (26)	• (26)	• (26)		• (1)				
2LMW7S 2LMW9D 2LMW13D 2LMW18S 2WMW3D 2WMW4D 2DMW11S 2DMW11D 3MW12S 3MW12D	Bedrock and overburden	Existing wells where radiological parameters exceeded screening levels.	2LGW7S 2LGW9D 2LGW13D 2LGW18S 2WGW3D 2WGW4D 2DGW11S 2DGW11D 3GW12S 3GW12D			• (10)								• (10)	
2LMW19D[1] 2LMW19S 2LMW20D[1] 2LMW20S	Bedrock/100' below bedrock surface Overburden/20±'	Further assessment of the ground water flow directions between the southeast portion of Area A Landfill and homes served by private wells near NSB-NLON east gate; evaluate ground water quality.	2LGW19D 2LGW19S 2LGW20D 2LGW20S			• (4)	• (4)	• (4)	• (4)						
2WMW21S 2WMW21D[1] 2WMW22D[1] 2DMW23D	Bedrock/100' below bedrock surface Overburden/20±'	Further assessments of the ground water flow directions between Area A Wetland and homes serviced by private wells near the east and north NSB-NLON boundaries. Evaluate ground water quality potentially upgradient of affected site areas.	2WGW21S 2WGW21D 2WGW22D 2DGW23D			• (4)	• (4)	• (4)	• (4)						
2WMW5D	Bedrock/20' (minimum penetration of bedrock)	Better define bedrock ground water flow direction within Area A Wetland; evaluate ground water quality.	2WGW5D			• (1)	• (1)	• (1)	• (1)						
2DMW24D 2DMW24S 2DMW25D 2DMW25S 2DMW26D 2DMW26S 2DMW27D 2DMW27S 2DMW28D 2DMW28S 2DMW29S 2DMW30S	Bedrock/20' (minimum penetration of bedrock) Overburden/20±'	Further evaluate extent of ground water contamination downgradient of Area A Landfill; further evaluate ground water quality/hydrology near North Lake.	2DGW24D 2DGW24S 2DGW25D 2DGW25S 2DGW26D 2DGW26S 2DGW27D 2DGW27S 2DGW28D 2DGW28S 2DGW29S 2DGW30S			• (12)	• (12)	• (12)	• (12)						

TABLE 7-21 (continued)
AREA A FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type			Analysis								
				Soil (No. of Samples)	Sediment (No. of Samples)	Water (No. of Samples)	VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	Dioxin	RAD	Engineering[4]
2WCMW1S 2WCMW2S 2WCMW3S	Overburden/20±'	Define ground water flow directions and hydraulic gradients near Weapons Center; evaluate ground water quality.	2WCGW1S 2WCGW2S 2WCGW3S			● (3)	● (3)	● (3)	● (3)						
2WCMW1S 2WCMW2S 2WCMW3S	Overburden/20±'	Provide chemical data for soils collected from the Weapons Center.	2WCMW1S (depth) 2WCMW2S (depth) 2WCMW3S (depth)	● (3)			● (3)	● (3)	● (3)						● (1)
2LPW1S	Overburden pump test/ base of saturated thickness	Located in an area considered to represent the average hydrogeologic conditions of Area A Landfill.	2LPW1S			● (3)	●[5] (7)	● (3)	● (3)		● (3)				● (3)
Test Borings															
2LTB8 through 2LTB27	NA/15'	Define lateral and vertical extent and degree of contamination identified around Area A concrete pad. Ten soil samples will be collected for analysis based on GC field screening for PCB and organic vapor analyzer screening for VOCs.	2LTB8 (depth) through 2LTB27 (depth)	● (10)			● (10)	● (10)	● (10)	● (10)	● (10)	● (2)			● (2)
2LTB13 2LTB23	NA/15'	Located in landfill area where dibenzofuran and ash have been detected.	2LTB13 (depth) 2LTB23 (depth)	● (2)									● (2)		
2LTB28 through 2LTB32	NA/15'	Optional borings at Area A concrete pad to be installed to determine the lateral extent of soil contamination (if contamination is detected during field screening). Three soil samples will be collected for analysis based on GC field screening for PCB and total organic vapor analyzer screening for VOCs.	2LTB28 (depth) through 2LTB32 (depth)	● (3)			● (3)	● (3)	● (3)	● (3)	● (3)				
2LC1 through 2LC4	NA/15'	Core samples of the pad to determine if it is contaminated.	2LC1 through 2LC4	● (4)							● (4)				
2WCTB1 2WCTB2 2WCTB3 2WCTB4 2WCTB5 2WCTB6 2WCTB7 2WCTB8	NA/15'	Provide chemical data for soils collected from the Weapons Center area.	2WCTB1 (depth) 2WCTB2 (depth) 2WCTB3 (depth) 2WCTB4 (depth) 2WCTB5 (depth) 2WCTB6 (depth) 2WCTB7 (depth) 2WCTB8 (depth)	● (8)			● (8)	● (8)	● (8)	● (4)	● (4)	● (1)			● (1)
2DTB1	NA/10'	Optional boring to be installed if soil gas survey indicates presence of VOCs in vicinity.	2DTB1 (depth)	●			●								
			Subtotal Soil Samples	31			25	24	24	17	21	3	2	0	4
			Subtotal Ground Water Sampling[2]			63	57	53	53	0	4	0	0	10	3

TABLE 7-21 (continued)
AREA A FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type: Soil (No. of Samples)	Sample Type: Sediment (No. of Samples)	Sample Type: Water (No. of Samples)	Analysis: VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	Dioxin	RAD	Engineering[4]
Sediment Sampling															
2WSD10 through 2WSD42	0-1' Below sediment surface	Provide additional pesticide analytical data in Area A wetland to confirm that elevated levels of pesticides are not present. Ten soil samples will be collected for analysis based on GC field screening for pesticides.	2WSD10 (0-1') through 2WSD42 (0-1')		● (10)					● (10)		● (1)			● (1)
2DSD14 through 2DSD29 3SD3A 3SD4A 3SD5A 3SD7	0' to base of sediments at the following intervals 0-1', 1-3', and 3-5'.	Define lateral and vertical extent and degree of pesticides in Area A downstream pond sediments. Ten soil samples will be collected for analysis based on GC field screening for pesticides. ~~Full CLP analysis to be performed on samples 2DSD24 through 2DSD29.~~	2DSD14 (depth) through 2DSD29 (depth) 3SD3A 3SD4A 3SD5A 3SD7		● (10)		● (6)	● (6)	● (6)	● (10)	● (6)	● (1)			● (5)
2DSD30	0-1'	At ground water seep into North Lake.	2DSD30		● (1)		● (1)	● (1)	● (1)	● (1)	● (1)				
2DSD31	0-1'	At ground water seep into North Lake.	2DSD31		● (1)		● (1)	● (1)	● (1)	● (1)	● (1)				
2DSD32	0-1'	At ground water seep into North Lake.	2DSD32		● (1)		● (1)	● (1)	● (1)	● (1)	● (1)				
2WCSD1 through 2WCSD15	0-1'	Provide chemical data for sediments collected from areas of surface water flow from the Weapons Center; samples for VOC, PCB, and pesticide analysis selected at culvert outlets and upgradient locations within Weapons Center.	2WCSD1 through 2WCSD15		● (15)		● (6)	● (15)	● (15)	● (6)	● (6)	● (1)			● (2)
2WCSD11	0-1'	Located in area where dibenzofurans have been detected.	2WCSD11		● (1)								● (1)		
3SD6	0' to base of sediments	Located in area where dibenzofurans have been detected.	3SD6 (depth)		● (1)								● (1)		
			Subtotal Sediment Sampling	0	40	0	15	24	24	29	15	3	2	0	8
Surface Soil Sampling															
2DSS1 through 2DSS18	0-6" below grade	Provide chemical data for surficial soil samples from Area A downstream watercourse. Four surface soil samples will be collected for analysis based on GC field screening for pesticides.	2DSS1 (0-6") through 2DSS18 (0-6")	● (5)						● (5)					

TABLE 7-21 (continued)
AREA A FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type: Soil (No. of Samples)	Sample Type: Sediment (No. of Samples)	Sample Type: Water (No. of Samples)	Analysis: VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	Dioxin	RAD	Engineering[4]
2DSS19 through 2DSS23	0-6" below grade	Optional sample locations to be installed (if required) to determine the lateral extent of soil contamination. If additional contamination is detected during field screening, two surface soil samples will be collected for analysis based on GC field screening for pesticides.	2DSS19 (0-6") through 2DSS23 (0-6")	• (2)						• (2)					
			Subtotal Surface Soil	7	0	0	0	0	0	7	0	0	0	0	0
		Surface Water													
2WSW1	Existing	Upgradient adjacent to wetland.	2WSW1			• (1)	• (1)		• (1)	• (1)					
2WSW2	Existing	At wetland outlet.	2WSW2			• (1)	• (1)	• (1)	• (1)	• (1)	• (1)				
2WCSW3		Upgradient of wetland at stormwater under drain outlet from Weapons Center.	2WCSW3			• (1)	• (1)	• (1)	• (1)	• (1)	• (1)				
2WCSW4		Upgradient of wetland at outlet from Weapons Center storm drain.	2WCSW4			• (1)	• (1)	• (1)	• (1)	• (1)	• (1)				
2WCSW5		Upgradient of wetland at outlet from Weapons Center storm drain.	2WCSW5			• (1)	• (1)	• (1)	• (1)	• (1)	• (1)				
2WSW6		Northeast section of wetland.	2WSW6			• (1)	• (1)		• (1)	• (1)					
2WSW7		Upgradient of wetlands in small drainage swale from Route 12.	2WSW7			• (1)	• (1)		• (1)	• (1)					
2WSW8 2WSW9		Upgradient of wetland at stormwater outlets from "urban areas".	2WSW8 2WSW9			• (2)	• (2)		• (2)	• (2)					
2WSW11		From pond in Area A wetland.	2WSW11			• (1)	• (1)		• (1)	• (1)					
2WSW10 2WSW12		Upgradient of wetland at stormwater outlet.	2WSW10 2WSW12			• (2)	• (2)		• (2)	• (2)					
4SW1 ~~4SW2~~		Upgradient ~~and downgradient, respectively~~ of Rubble Fill at Bunker A-86 (tabulated under Rubble Fill at Bunker A-86).	4SW1 4SW2												
2DSW2-5 2DSW7 2DSW9-11	Existing	Surface water sample locations previously sampled during Phase I which were located to measure water quality at various locations in Area A downstream surface waters; 2DSW9 and 2DSW11 analyzed for SVOCs and PCBs.	2DSW2-5 2DSW7 2DSW9-11			• (8)	• (8)	• (2)	• (8)	• (8)	• (2)				

TABLE 7-21 (continued)
AREA A FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type: Soil (No. of Samples)	Sample Type: Sediment (No. of Samples)	Sample Type: Water (No. of Samples)	Analysis: VOC	SVOC	Inorganics	Pesticides	PCB	TCLP	Dioxin	RAD	Engineering[4]
2DSW14		Upgradient of Area A downstream at stormwater outfall.	2DSW14			● (1)	● (1)		● (1)	● (1)					
2DSW15		Upgradient of Area A downstream at outfall from Torpedo Shops.	2DSW15			● (1)	● (1)		● (1)	● (1)					
7SW1	Existing	At downgradient location in Torpedo Shops. (Tabulated under Torpedo Shops.)	7SW1												
2DSW30-32		At ground water seep into North Lake.	2DSW30-32			● (3)	● (1)	● (1)	● (1)	● (1)	●				
			Subtotal Surface Water			25	25	7	23	23	7	0	0	0	0
			Total Solids	**78**			**40**	**48**	**48**	**48**	**36**	**6**	**4**	**0**	**12**
			Total Water[3]			**151**	**139**	**113**	**129**	**23**	**15**	**0**	**0**	**20**	**6**

PROPOSED

56 Primary test borings (including well borings)
5 Supplemental test borings
28 Wells
- 11 Deep bedrock wells
- 17 Shallow overburden wells

Notes:

[1] 100 feet penetration of bedrock to be representative of offsite residential well construction.
[2] Total includes one sampling round.
[3] Total includes two sampling rounds.
[4] All sediment samples will be analyzed for grain size and TOC.
[5] VOC samples should be collected at the following pump test intervals: start, 1 hour, 2 hours, 4 hours, 8 hours, 16 hours, and conclusion.

TABLE 7-21 (continued)
AREA A FIELD SAMPLING PLAN

ECOLOGICAL SAMPLING						
Sample Type	**Location**	**Sample Quantity**				**Analysis**
		Tissue	**Soil**	**Sediment**	**Bioassays**	
Area A - Qualitative Survey						
Qualitative soil invertebrate survey	Wetland, Downstream, OBDA					Qualitative
Fish	Downstream ponds	●[1] (3)				Qualitative/Pesticides
Area A - Quantitative Survey						
Native earthworms and soils	Downstream	● (5)	● (5)[3]			Pesticides
In situ earthworm bioassays in soils/wetland sediment	Wetland, Downstream, OBDA				● (15-20)	—
Introduced earthworms from bioassays and soils/wetland sediment	Wetland, Downstream, OBDA	● (5)	● (5)[3]			Pesticides
Earthworm bioassays in pond sediment	Downstream watercourses			● (6)[3]	● (9)[2]	Pesticides (sediment only)
Introduced earthworms from bioassays	Downstream watercourses	● (3)				Pesticides
Frogs	Downstream ponds and streams	● (9)				Pesticides
Benthic Invertebrates and reference location	Downstream ponds and streams	● (18)		● (18)[3]		Quantitative benthic analysis, reference area sediments for pesticides

Notes:
1 If larger fish are found, separate analysis will be conducted for tissue and liver for a total of six analyses.
2 Includes three reference locations.
3 Analysis included in Area A field sampling plan.

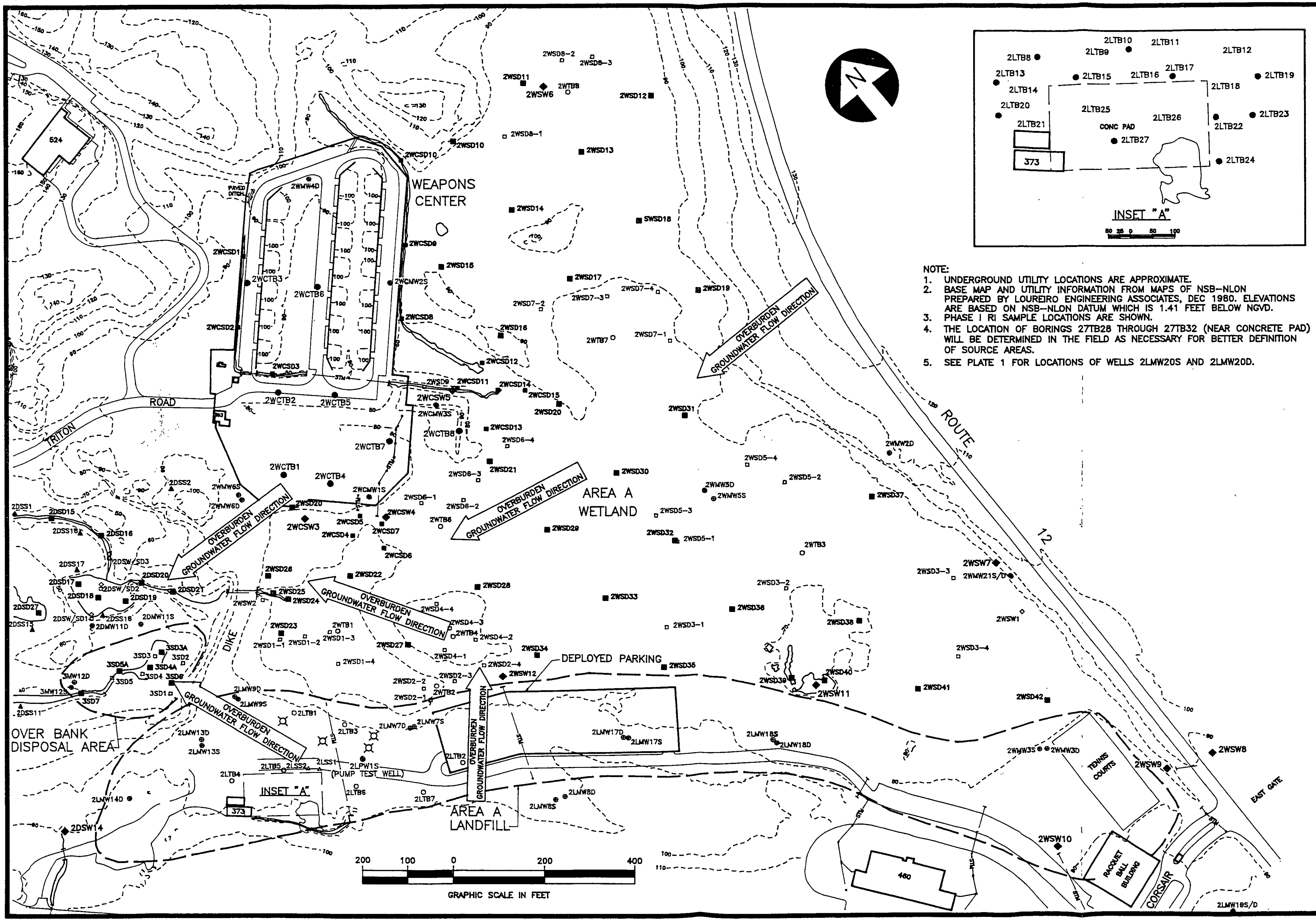
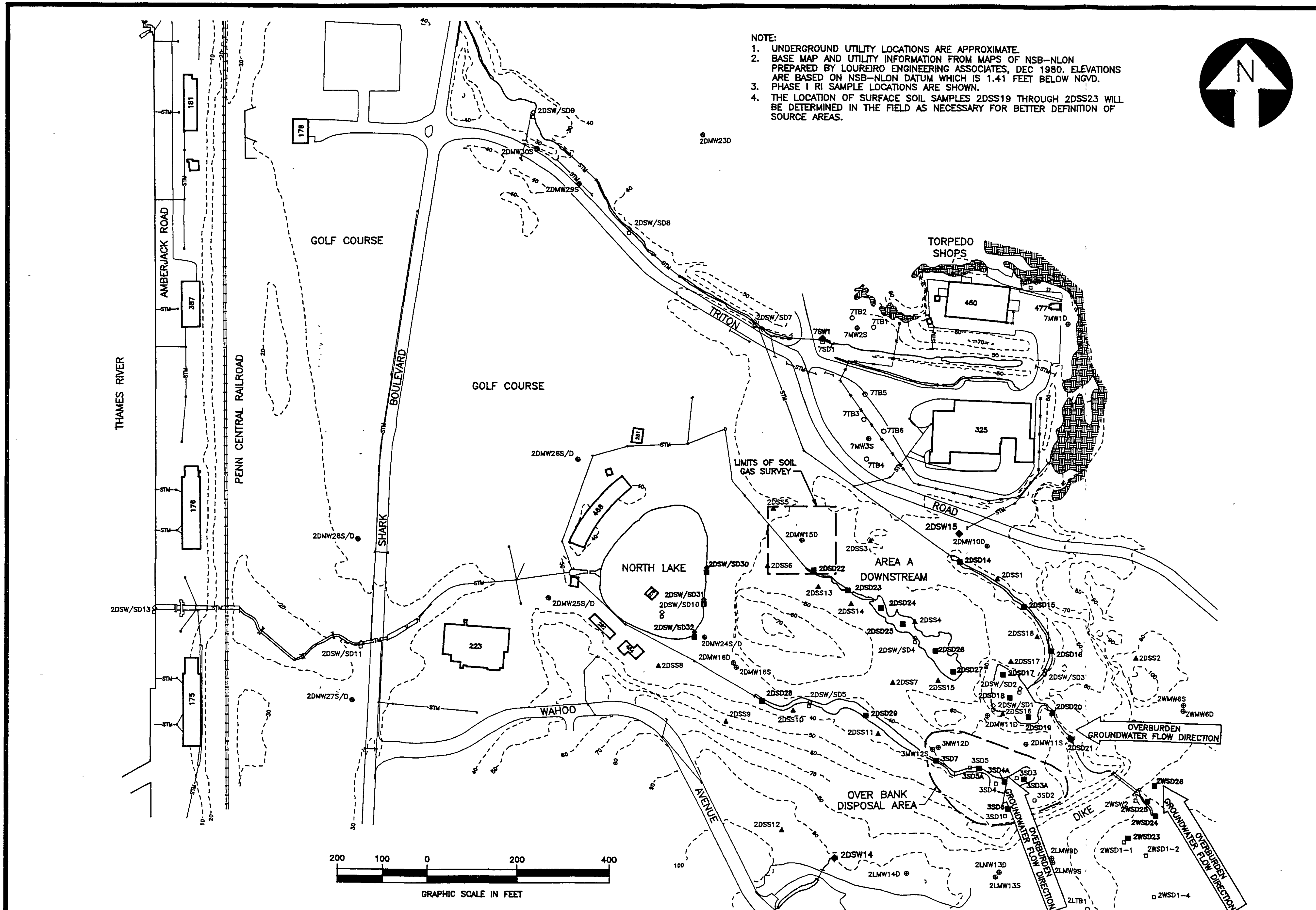


FIGURE 7-7
FIELD SAMPLING PLAN
AREA A LANDFILL, WETLAND AND WEAPONS CENTER

ATLANTIC ENVIRONMENTAL SERVICES, INC.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.



LEGEND

EXIST.	PROP.	
6MW1	7MW5	MONITORING WELL
6TB1	7TB5	TEST BORING
2DSD1	2DSD5	SEDIMENT SAMPLE
6SS1	7SS5	SURFACE SOIL SAMPLE
2DSW1	SDSW5	SURFACE WATER SAMPLE

- 10 - EXIST CONTOUR
- 123 BUILDING No.
- WATERCOURSE
- STM STORM SEWER
- CATCH BASIN

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FIGURE 7-8
FIELD SAMPLING PLAN
AREA A DOWNSTREAM/OBDA

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

- Further define the extent of lead, VOCs, PAHs, PCBs and pesticides in onsite soils, particularly in the north end of the site.

  - test borings and soil analysis will be conducted

- Further evaluate ground water quality to confirm previous sampling round results and to assess potential impacts to Thames River.

  - install additional shallow and deep overburden wells, sample and analyze all existing and proposed wells

- Determine if dioxin exists in subsurface soils.

  - collect soil samples from locations where dibenzofurans were previously detected

- Confirm that radiological constituents detected in ground water are from natural sources.

  - resample wells where radiological constituents previously exceeded action levels

- Update site geology and hydrology based on additional collected data.

  - to be based on additional test boring and monitoring well geology and hydrology data

- Update human health risk assessment based on additional collected data.

  - the human health risk assessment is discussed in Section 4.0

The remedial action objectives and associated investigative actions are included in Table 7-22. The rationale for selection of constituents for analysis is provided in Table 7-23. Table 7-24 provides details of the field sampling plan including location, number and type of samples; location rationale; and analysis requirements.

Figure 7-9, Plate 1 and Plate 2 illustrate the proposed sample locations.

7.3.3 Lower Subbase

The site investigation's specific goals are summarized below; the goals address the recommendations of the Phase I RI report and Technical Review Committee comments.

- Determine the nature and extent of lead contamination in area identified during the Phase I RI.

TABLE 7-22
DRMO
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations and other geologic features.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevation.
Geological Investigation	Better define stratigraphy below the landfill material and determine depth to bedrock. /Depth to bedrock has not been adequately determined.	Install borings and monitoring wells to bedrock. Core 5 feet into bedrock at locations 6TB17 and 6TB18.
Hydrogeologic Investigation	Further evaluate hydraulic conductivity at the site. /Hydraulic conductivity data for the site have been performed, however, supplemental verification will better define this parameter.	Perform a single well hydraulic conductivity test (6MW4S, 6MW3D). No further tests are required as hydraulic conductivity has been measured during the Phase I RI.
	Determine if there is temporal fluctuation of ground water elevations. /Temporal fluctuation of ground water elevations have not been previously investigated.	Perform ground water elevation measurements prior to each round of sampling at low tide. Collect data to prepare a base-wide ground water elevation map.
	Better define ground water flow directions. /Information regarding flow direction is limited for some areas of the site.	Prepare ground water flow direction maps based on each round of water levels collected.
Chemical Investigation Soils	Determine if dioxins are present in areas where dibenzofuran was previously detected. /Dioxin was not previously analyzed for.	Sample soils near areas where dibenzofurans were previously detected (6TB5, 6TB7).
	Further define the nature, extent and degree of soil contamination within the north portion of the landfill. /Extent and degree of soil contamination has not been adequately characterized.	Collect and analyze soil samples from proposed borings. Plot or contour concentrations of chemicals of concern on site maps.
Ground Water	Determine the source of radiological constituents (natural or anthropogenic) detected in ground water. /Source of elevated radiological constituents in ground water has not been independently verified.	Perform radiological analyses of ground water from the two wells displaying elevated levels in previous sampling rounds (6MW1S, 6MW4S).
	Evaluate potential temporal changes in ground water quality; collect additional health and ecological risk assessment data. /Temporal fluctuation of ground water quality has not been fully characterized.	Perform two rounds of ground water sampling and analyses.
	Determine if a downward migration of contamination has occurred. /Deep bedrock monitoring wells were not previously installed within the site boundaries.	Analyze ground water from both the deep and shallow wells at the site.
	Determine upgradient ground water quality. /Proposed monitoring wells 6MW6D as 6MW6S are located closer to the site and are considered to be better representative of upgradient locations for the site.	Sample and analyze ground water from upgradient monitoring wells (6MW6D, 6MW6S).
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil and ground water samples for specified engineering characteristic parameters.

TABLE 7-23
DRMO
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Detected in soil and ground water samples collected during Step II.
SVOC[2]	●	Detected in soil and ground water samples collected during Step II.
Inorganics[3]	●	Detected in soil and ground water samples collected during Step II.
Pesticides	●	Detected in soil samples collected during Step II, but not ground water. Not included in proposed ground water analysis.
PCB[4]	●	Detected in soil samples collected during Step II, but not ground water. Not included in proposed ground water analysis.
TCLP[5]	●	Determine hazardous waste characteristics for select samples.
Dioxins[6]	●	Dibenzofuran detected in soil samples during Step II.
Radiological Analyses[7]	●	Detected in certain ground water samples collected during Step II. Analyze only for ground water samples exceeding action level in Step II.
Engineering Characteristics[8]	●	Feasibility study data requirements for select samples.

Notes:

1 VOC means volatile organic compound listed in the CLP TCL.

2 SVOC means semi-volatile organic compound listed in the CLP TCL.

3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.

4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.

5 TCLP means toxicity characteristic leaching procedures.

6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.

7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.

8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).

TABLE 7-24
DRMO FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type		Analysis								
				Soil	Water	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	Dioxin	RAD[4]	Engi-neering
Monitoring Wells														
6MW1S	Existing	Existing	6GW1S		●	●	●	●					●	
6MW2S	Existing	Existing	6GW2S		●	●	●	●						
6MW2D[1]	Overburden/50±' (advance boring to determine bedrock contact)	Monitor quality of deep ground water discharging to river; existing shallow soil analytical data available from 6MW2S.	6GW2D		●	●	●	●						
			6MW2D (depth)	●		●	●	●	●	●				
6MW3S	Existing	Existing	6GW3S		●	●	●	●						●
6MW3D[1]	Overburden/50±' (advance boring to determine bedrock contact)	Monitor quality of deep ground water discharging to river; existing shallow soil analytical data available from 6MW3S.	6GW3D		●	●	●	●						
			6MW3D (depth)	●		●	●	●	●	●				●
6MW4S	Existing	Existing	6GW4S		●	●	●	●					●	
6MW5S	Existing	Replaced with new upgradient well 6MW6S												
6MW5D	Existing	Replaced with new upgradient well 6MW6D												
6MW6S	Overburden/20±'	Monitor quality of ground water upgradient of site.	6MW6S (depth)	●		●	●	●	●	●				
			6GW6S		●	●	●	●						
6MW6D[1]	Overburden/50±' (advance boring to determine bedrock contact)	Monitor quality of deep ground water upgradient of site.	6GW6D		●	●	●	●						
6MW7S	Overburden /20±'	Evaluate ground water quality in the southeast portion of the site; ground water elevation data.	6MW7S (depth)	●		●	●	●	●	●				
			6GW7S		●	●	●	●						
6MW8S	Overburden /20±'	Evaluate ground water quality in the vicinity of previously detected contaminants.	6MW8S (depth)	●		●	●	●			●			
			6GW8S		●	●								
Test Borings														
6TB8	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow sample from unpaved area.	6TB8 (0-1)	●		●	●	●	●	●				
			6TB8 (depth)	●		●	●	●	●	●				
6TB9	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB9 (depth)	●		●	●	●	●	●				
6TB10	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB10 (depth)	●		●	●	●	●	●				
6TB11	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB11 (depth)	●		●	●	●	●	●				
6TB12	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB12 (depth)	●		●	●	●	●	●				
6TB13	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow samples near area of contamination.	6TB13 (0-1)	●		●	●	●	●	●				
			6TB13 (depth)	●		●	●	●	●	●				
6TB14	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB14 (depth)	●		●	●	●	●	●				

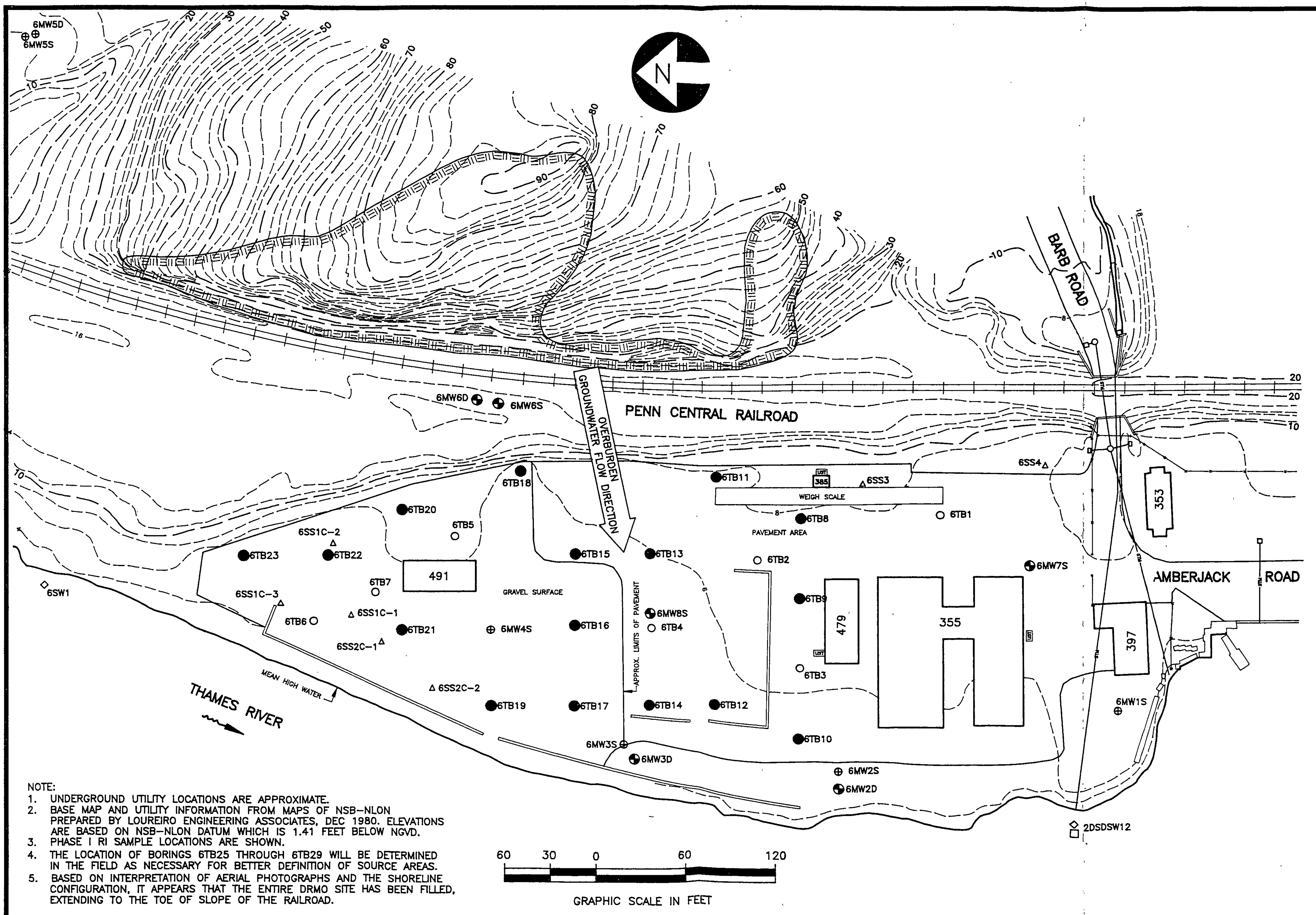
TABLE 7-24 (continued)
DRMO FIELD SAMPLING PLAN

Sample Location	Well Type/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type		Analysis								
				Soil	Water	VOC	SVOC	Inor-ganics	Pesti-cides	PCB	TCLP	Dioxin	RAD[4]	Engi-neering
6TB15	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB15 (depth)	●		●	●	●	●	●				
6TB16	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow sample from unpaved area.	6TB16 (0-1)	●		●	●	●	●	●				
			6TB16 (depth)	●		●	●	●	●	●				●
6TB17	NA/Base of fill (15±')	Further define the extent and degree of contamination.	6TB17 (depth)	●		●	●	●	●	●				
6TB18	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow sample from unpaved area.	6TB18 (0-1)	●		●	●	●	●	●				
			6TB18 (depth)	●		●	●	●	●	●				
6TB19	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow sample from unpaved area.	6TB19 (0-1)	●		●	●	●	●	●				
			6TB19 (depth)	●		●	●	●	●	●				
6TB20	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow sample from unpaved area.	6TB20 (0-1)	●		●	●	●	●	●				
			6TB20 (depth)	●		●	●	●	●	●	●	●		●
6TB21	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow surface soil data available at 6SS2C.	6TB21 (depth)	●		●	●	●	●	●		●		●
6TB22	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow surface soil data available at 6SS1C.	6TB22 (depth)	●		●	●	●	●	●				●
6TB23	NA/Base of fill (15±')	Further define the extent and degree of contamination. Shallow surface soil data available at 6SS1C.	6TB23 (0-10)	●		●	●	●	●	●				
6TB24-6TB28	NA/Base of fill (15±')	Optional resolution borings to be installed to determine extent of soil contamination, if required, based upon the field screening results.	6TB24-28 (depth)	● (5)		● (5)	● (5)	● (5)	● (5)	● (5)				
			Subtotal Soil	32		32	32	32	31	31	2	2	0	5
			Subtotal Ground Water[2]		10	10	9	9	0	0	0	0	2	1
			Total Soil	**32**		**32**	**32**	**32**	**31**	**31**	**2**	**2**	**0**	**5**
			Total Ground Water[3]		**20**	**20**	**18**	**18**	**0**	**0**	**0**	**0**	**4**	**2**

PROPOSED

22 Primary test borings (including well borings)
5 Supplemental test borings
5 Wells
  2 - Shallow overburden
  3 - Deep overburden or bedrock

Notes:
1 Bedrock well may be installed, see Field Sampling Plan for details.
2 One round of sampling.
3 Includes two sampling rounds.
4 RAD means gamma spectrum analysis and gross alpha/beta analysis.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
4. THE LOCATION OF BORINGS 6TB25 THROUGH 6TB29 WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF SOURCE AREAS.
5. BASED ON INTERPRETATION OF AERIAL PHOTOGRAPHS AND THE SHORELINE CONFIGURATION, IT APPEARS THAT THE ENTIRE DRMO SITE HAS BEEN FILLED, EXTENDING TO THE TOE OF SLOPE OF THE RAILROAD.

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FIGURE 7-9
FIELD SAMPLING PLAN
DRMO

LEGEND

---10---	EXIST CONTOUR
123	BUILDING No.
═	WATERCOURSE
—STM—	STORM SEWER
□	CATCH BASIN

EXIST.	PROP.	
⊕ 6MW1	7MW5	MONITORING WELL
○ 6TB1	7TB5	TEST BORING
□ 2DSD1	■ 2DSD5	SEDIMENT SAMPLE
△ 6SS1	▲ 7SS5	SURFACE SOIL SAMPLE
◇ 2DSW1	◆ 2DSW5	SURFACE WATER SAMPLE

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

- Determine the extent of subsurface free product near Bower House underground storage tanks.

- Further evaluate ground water quality to confirm previous sampling round results and confirm previous assumptions made regarding SVOC ground water concentrations used in the Phase I RI; ground water quality data will also be used for the Thames River ecological assessment.

- Update human health risk assessment based on additional collected data.

The remedial action objectives and associated investigative actions are included in Table 7-25. The rationale for selection of constituents for analysis is provided in Table 7-26. Table 7-27 provides details of the field sampling plan including location, number and type of samples; location rationale; and analysis requirements.

Figure 7-10 illustrates the proposed sample locations.

The general approach for the supplemental Step II investigation at the Lower Subase is as follows. The primary focus of this investigation is to further define the extent of lead contamination in soils. The field investigations will rely heavily on XRF analysis in the field to select samples and determine the need for supplemental borings. In addition to this focussed investigation of lead contamination in soils, another two rounds of ground water samples will be collected to confirm previous results and risk assessment assumption, and to define any temporal changes in ground water quality. Ground water quality data will also be used for the Thames River ecological assessment.

TABLE 7-25
LOWER SUBASE
REMEDIAL INVESTIGATION OBJECTIVES

Activity	Objectives/Data Gaps	Action
Site Mapping	Map proposed sample locations.	Use existing site survey maps to draft site maps using AutoCAD®. Survey sample locations and elevations.
Chemical Investigation Soils	Determine extent and degree of lead contamination. /Extent and degree of lead contamination not fully characterized at the site.	Perform borings and collect samples continuously to bottom of fill (15± feet). Analyze samples for total lead, TCLP lead, and TPH. Samples selected for analysis will be based upon XRF field screening results.
	Determine if free product exists near power house (Building 29) underground storage tanks. /No wells exist at a location where oil was observed in an excavation.	Install one well in the area where subsurface oil was observed in an excavation. If recoverable amounts of free product are present, install seven additional wells to determine the extent of petroleum and VOC contamination. Inspect this well on a monthly basis for product thickness.
Ground Water	Determine whether temporal fluctuations in chemical quality occur in ground water and the extent of VOC contamination. Confirm first round of analytical data and previous assumptions made regarding SVOC concentrations in ground water. /Temporal fluctuation of ground water quality has not been fully evaluated.	Perform two additional rounds of ground water monitoring and analyze for all TCL and TAL parameters including VOC.
Engineering Investigation	Determine soil physical properties and ground water quality properties for use in Feasibility Study evaluation. /No information exists regarding specific engineering characteristics of site soils and water.	Collect and analyze select soil and ground water samples for specified engineering characteristic parameters.

TABLE 7-26
LOWER SUBASE
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS

Parameter	Selected	Rationale
VOC[1]	●	Detected in soil and ground water samples during Step II.
SVOC[2]	●	SVOCs could be present in ground water; not previously analyzed.
Inorganics[3]	●	Detected in soil and ground water during Step II.
Pesticides		Not suspected to be present.
PCB[4]		Not suspected to be present.
TCLP[5]	●	Determine hazardous waste characteristics for select soil samples.
Radiological Analyses[6]		Radiological constituents are not suspected at this site.
Dioxin[7]		Historically, volatile organic compounds have not been burned at this site.
Engineering Characteristics[8]	●	Feasibility study data requirements for select samples.
TPH[9]	●	Useful in determining extent of petroleum contamination.

Notes:

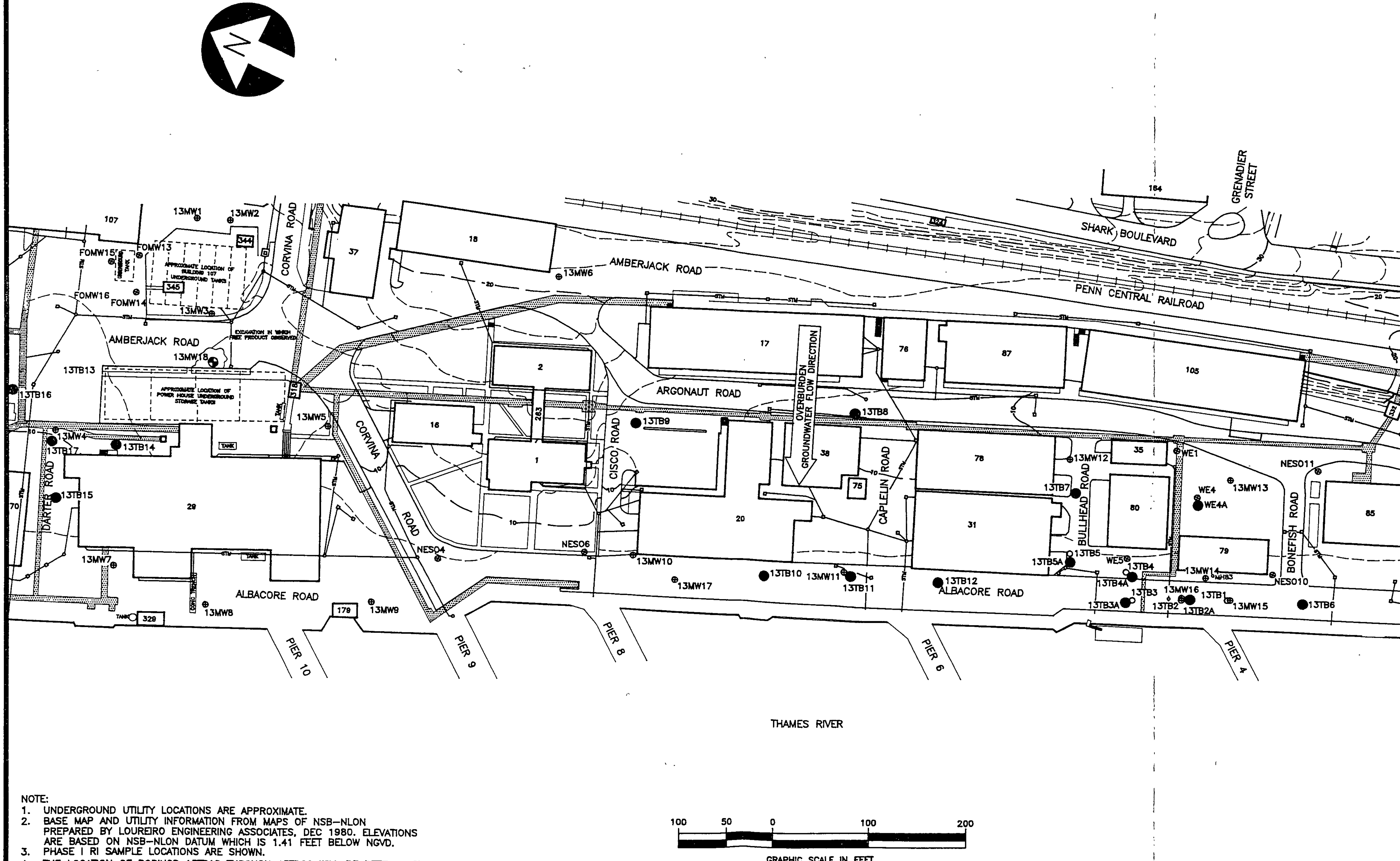
1 VOC means volatile organic compound listed in the CLP TCL.
2 SVOC means semi-volatile organic compound listed in the CLP TCL.
3 Inorganics include total and dissolved inorganics for ground water samples and dissolved inorganics for surface water. All CLP TAL compounds and boron are included in this category.
4 PCB means polychlorinated biphenyl. All arochlors in the CLP TCL will be analyzed.
5 TCLP means toxicity characteristic leaching procedures.
6 Radiological analyses include gross alpha and beta and a complete gamma spectrum analysis.
7 Dioxin analysis includes dioxins and dibenzofurans as specified in U.S. EPA CLP SOW DFLM01.0.
8 Engineering characteristics for soils include grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and total organic carbon content; and for ground water includes biochemical oxygen demand (5-day), chemical oxygen demand, total organic carbon, oil and grease (hydrocarbon fraction), total suspended solids, hardness, ammonia (as nitrogen) and phosphorus (total).
9 TPH means total petroleum hydrocarbons.

TABLE 7-27
LOWER SUBASE FIELD SAMPLING PLAN

Sample Location	Well Depth/ Proposed Depth (ft)	Rationale	Sample Designations	Sample Type		Analysis								
				Soil	Water	VOC	SVOC	Inorganics	Pesticides	PCB	Lead	TCLP[1]	TPH	Engineering
13TB2A-5A	15 feet or bottom of sand and gravel fill layer, whichever is deeper	At and around 13MW11 and 13MW16 where high TCLP lead was detected during the Phase I RI.	13TB2A-5A (depth)	• (4)							• (4)	• (4)	• (4)	• (1)
13TB6-12	15 feet or bottom of sand and gravel fill layer, whichever is deeper	At and around 13MW11 and 13MW16 where high TCLP lead was detected during the Phase I RI.	13TB6-12 (depth)	• (7)							• (7)	• (7)	• (7)	• (1)
13TB13-13TB17	15 feet or bottom of sand and gravel fill layer, whichever is deeper	At and around 13MW4 where high TCLP lead was detected during Phase I RI	13TB13-17 (depth)	• (5)							• (5)	• (5)	• (5)	
WE-4A	15 feet or bottom of sand and gravel fill layer, whichever is deeper.	At and around 13MW11 and 13MW16 where high TCLP lead was detected during the Phase I RI.	WE-4A (depth)	•							•	•	•	
13TB18-22	15 feet or bottom of sand and gravel fill layer, whichever is deeper.	Optional resolution borings to be installed to determine full extent of soil contamination if detected based upon field screening.	13TB18-22 (depth)	• (5)							• (5)	• (5)	• (5)	
24 existing monitoring wells	NA	Existing wells			• (24)	• (24)	• (24)	• (24)					• (24)	• (1)
13MW18	15 feet or 10 feet below ground water elevation, whichever is deeper.	At location where oil was observed in an excavation.	13GW18		•	•	•	•					•	
13MW19-25	15 feet or 10 feet below ground water elevation, whichever is deeper.	Optional wells to be installed to determine extent of recoverable product if detected in 13MW18.	13GW19-25		•	•	•	•					•	
			Subtotal Soil	22		0	0	0	0	0	22	22	22	2
			Subtotal Ground Water[2]		26	26	26	26	0	0	0	0	26	1
			Total Soils	**22**		**0**	**0**	**0**	**0**	**0**	**22**	**22**	**22**	**2**
			Total Water[3]		**52**	**52**	**52**	**52**	**0**	**0**	**0**	**0**	**52**	**2**

PROPOSED
17 Primary test borings
5 Supplemental test borings

Notes:
1 Of the 22 TCLP analyses, 16 will only include metals and two will include all TCLP constituents. These two samples will be selected from samples that appear to have high levels of contamination based on field screening results.
2 Total is per one round of sampling.
3 Total includes all rounds of sampling.



NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB–NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB–NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
4. THE LOCATION OF BORINGS 13TB18 THROUGH 13TB22 WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF EXTENT OF CONTAMINATION.

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FIGURE 7–10
FIELD SAMPLING PLAN
LOWER BASE

LEGEND

---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—	STORM SEWER
□	CATCH BASIN

EXIST.	PROP.	
⊕ 6MW1	7MW5	MONITORING WELL
○ 6TB1	7TB5	TEST BORING
□ 2DSD1	■ 2DSD6	SEDIMENT SAMPLE
△ 6SS1	▲ 7SS5	SURFACE SOIL SAMPLE
◇ 2DSW1	◆ 2DSW5	SURFACE WATER SAMPLE

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

8.0 DATA QUALITY OBJECTIVES

The purpose of this section is to specify the requirements for the control of the accuracy, precision, and completeness of the samples and data from the point of collection through reporting. The QA/QC Plan outlines the organization, objectives, and all QA/QC activities which will ensure achievement of desired data quality goals.

The program to be implemented for this investigation will be performed under NEESA Level D quality control. Level D is equivalent to Level IV quality control as defined in the Superfund Manual *Data Quality Objectives for Remedial Response Activities* (U.S. EPA 540/G-87/003). The laboratory must successfully analyze a performance sample, undergo an audit, correct deficiencies found during the audit, and provide monthly progress reports on QA. The laboratory that performs Level D QC must also have successfully analyzed performance samples furnished by the U.S. EPA under the Superfund Contracting Laboratory Program (CLP) in the past year.

Audits will be administered and evaluated by the NEESA Contract Representative (NCR). The Navy audit and performance samples are required in addition to any specified by the U.S. EPA Superfund Program.

Level D requires use of CLP procedures as defined in the U.S. EPA Contract Laboratory Program *Statement of Work for Inorganics Analysis* (7/88), and *Statement of Work for Organics* (2/88). Data validation procedures under Level D must be conducted in accordance with U.S. EPA Region I Laboratory Data Validation Functional Guidelines dated February 1, 1988 for organic analyses, and June 13, 1988 for inorganic analyses.

The data quality objectives for all measurements (field and laboratory) include considerations of precision, accuracy, and completeness as described below in general terms. Detailed quality control objectives can be found in the QA/QC Plan.

8.1 Precision

The precision of a measurement is an expression of mutual agreement of multiple measurement values of the same property conducted under prescribed similar conditions. Precision reflects the repeatability of the measurement. Precision is evaluated most directly by recording and comparing multiple measurements of the same parameter on the same sample under the same conditions. Precision is usually expressed in terms of standard deviation. The precision objectives for TCL parameters are specified in the CLP protocols. Except as otherwise specified by the method, the QC objective for precision under this project will be ± 30 percent (aqueous sample) (relative percent difference) or ± 50 percent (soil sample) as determined by duplicate analyses. The relative percent difference (RPD) is calculated as:

$$RPD = \frac{1}{2} x \frac{V1 - V2}{V1 + V2} x\ 100$$

Where: V1, V2 = two values obtained by analyzing duplicates

8.2 Accuracy

The degree of accuracy of a measurement is based on a comparison of the measured value with an accepted reference or true value, or is a measure of system bias. Accuracy of an analytical procedure is best determined based on analysis of a known or "spiked" sample quantity. The degree of accuracy and the recovery of analyte to be expected for the analysis of QA samples and spiked samples is dependent upon the matrix, method of analysis, and compound or element being determined in the analysis. The concentration of the analyte relative to the detection limit is also a major factor in determining the accuracy of the measurement. Except as otherwise specified by a method, the QC objective for accuracy under this project will be 75 to 125 percent (percent recovery), as determined by sample spike recoveries. Alternatively, accuracy may be assessed through the analysis of appropriate standard reference materials, certified standards, or other samples, as available. The percent recovery is calculated as:

$$\%\ recovery = \frac{Ss - So}{S} \times 100$$

Where: Ss = Value obtained by analyzing the sample with the spike added.
So = Background value, i.e., the value obtained by analyzing the sample without a spike.
S = Concentration of the spike added to Ss.

8.3 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system relative to the amount anticipated under ideal conditions. This project's QC objective for completeness, as determined by the percentage of valid data generated, will be $\geq$ 90 percent. The formula to be used to estimate completeness is:

$$C = 100 \frac{V}{T}$$

Where: C = Percent Completeness
V = Number of judgements determined valid
T = Total number of measurements

9.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

The remedial investigation is conducted to provide data that can be used to determine the nature, extent, and degree of contamination at a site and to identify if a site poses risks to human health or the environment. The feasibility study is conducted to develop and evaluate remedial alternatives for site contamination. The RI/FS tasks described in this Work Plan have been developed to meet these objectives. This section of the Work Plan follows the standard format outlined in the *RI/FS Guidance* (U.S. EPA 1988a).

9.1 RI/FS Tasks

The following tasks have been identified for the RI/FS:

- Task 1 - Project Planning
- Task 2 - Community Relations Activities
- Task 3 - Field Investigations
- Task 4 - Sample Analysis/Data Validation
- Task 5 - Data Evaluation
- Task 6 - Risk Assessment
- Task 7 - Remedial Investigation Report
- Task 8 - Remedial Alternative Development
- Task 9 - Alternatives Evaluation
- Task 10 - Feasibility Study Report
- Task 11 - Treatability Studies

9.1.1 Project Planning

Included in this task are limited field investigation activities consisting of site inspections, existing data evaluation, and development of the Work Plan; obtaining appropriate approvals for the Work Plan, and schedule; preparation of the Quality Assurance/Quality Control Data Management Plan (QA/QC) and the Field Sampling Plan (FSP); preparation of the Health and Safety Plan (HASP); project management and agency coordination; and contract negotiations and meetings among the Navy, U.S. EPA, CTDEP, Atlantic, and other members of the Technical Review Committee (TRC).

Development of the Phase II RI/FS Work Plan includes formulation of DQOs, identification of the necessary RI/FS tasks, and preparation of schedules for implementing the proposed RI/FS tasks. Results of the existing data evaluation, including results of the Phase I RI, are presented in Section 2.0. This existing data was also used to develop Section 3.0 of this document, and to develop the scope of RI activities. Potential ARARs and remedial action alternatives for the subject site are discussed in Section 6.0 of this document. This information was also utilized to develop the scope of Phase II RI activities.

The Work Plan provides a summary of the project background and the objectives and goals of the proposed activities. The QA/QC Plan specifies the analytical procedures and the methods for analytical choices and data reduction, validation, and reporting. The FSP indicates proposed sampling locations, collection procedures, field screening procedures, and the equipment necessary for sampling and testing. The HASP specifies health and safety procedures to be implemented by all onsite personnel during the investigation.

At critical junctures of the project, it will also be necessary to conduct meetings between U.S. EPA, CTDEP, TRC members, and other appropriate parties to discuss project deliverables and the schedule and to evaluate the need for additional studies. TRC meetings will be held on a regular basis and will normally be held at NSB-NLON.

9.1.2 Task 2 - Community Relations Activities

A draft community relations plan has been prepared addressing activities that the Navy will conduct with residents and government officials involved with the site. The plan contains the following sections:

- Introduction
- Basic Description: Location, History and Miscellaneous
- The Installation Restoration Program: How the Process Works
- Environmental Profile: The Sites
- Area Profile
- Key Community Concerns
- Proposed Community Relations Activities

Information presented in the plan was developed from previous work conducted at the site and interviews conducted with federal, state and local officials, and residents.

Public meetings will normally be held in the evening on the same day as TRC meetings. To keep the public informed, a fact sheet announcing the results of the Phase I Remedial Investigation has been completed, and the following fact sheets are planned:

- community concerns about North Lake
- preferred remedial options for each of the investigation sites

A proposed plan summarizing the alternative selection process and the preferred remedial action alternative will be prepared for public comments. A final fact sheet will be prepared after the ROD is signed to explain the remedial action alternative selected for the site.

9.1.3 Task 3 - Field Investigation

Accompanying this Work Plan is an FSP, QA/QC plan, and HASP. The contents of these plans are listed below. For further details, the plans themselves can be consulted, and a summary of samples to be collected and analyses to be performed is provided in Section 7.0 of this report.

Field Sampling Plan

- Introduction
- Site Background

  Supplemental Step II Investigation
  Step II Investigations
  Supplemental Step II Investigations

- Field Mobilization

  Field Office
  Equipment Storage and Decontamination Area
  Field Laboratory
  Waste Storage Area
  Sampling Locations
  Heavy Equipment Mobilization
  Emergency Procedures
  Onsite Safety Briefing

- Field Investigation General Procedures

  Field Screening
  Soil Gas Survey
  Test Boring and Sampling
  Well Construction
  Evaluation of Aquifer Hydraulic Properties
  Surface Soil Sampling
  Surface Water and Sediment Sampling
  Dioxins/Dibenzofurans Sampling
  Surveying and Mapping
  Geologic Surveys
  Ecological Studies
  Air Monitoring
  Waste Classification and Disposal

- Field Investigation Site Specific Procedures

  Supplemental Step I Investigation
  Step II Remedial Investigation
  Supplemental Step II Remedial Investigation

- Sample Preservation and Shipping
- Record Keeping and Documentation
- Project Schedule

QA/QC Plan

- Introduction
- Project Organization and Responsibilities
- Sampling Procedures

  Introduction
  Selection of Sampling Locations
  Sample Collection, Handling and Shipping
  Field Quality Control Samples
  Field Decontamination Procedures

- Chain-of-Custody
- Analytical Procedures

  Laboratory Procedures
  Field Procedures

- Data Validations
- Data Quality Objectives
- Corrective Action
- Data Management Plan

Health and Safety Plan

- Introduction
- Medical Surveillance Program
- Emergency Support and Procedures
- Training Programs
- Site Safety Plan

  Introduction and Site Descriptions
  Site Safety Plan Objectives
  Authorized Site Personnel and Their Responsibilities
  Control of Site Access
  Evaluation of Potential Hazards
  Levels of Protection for Site Workers
  Communication Procedures
  Decontamination Procedures
  Location of Buried Utilities
  Engineering Controls and Work Practices
  Handling Drums and Containers
  Illumination
  Sanitation for Temporary Work Sites
  Biological Sampling

9.1.4 Task 4 - Sample Analysis and Data Validation

9.1.4.1 Subtask 4A - Onsite Mobile Laboratory

This subtask includes mobilization, operation, and demobilization of the mobile laboratory at the site. The mobile laboratory will be used for screening soil samples for:

- DDT and PCB using a portable GC (gas chromatograph) unit
- lead using a portable XRF (X-ray fluorescence) unit
- VOC using an organic vapor analyzer

All analytical data will be tabulated and organized in the field. The screening data will be used to direct drilling of supplemental boring. Samples will be selected for offsite laboratory analysis based on screening results. The offsite laboratory data will be evaluated with the field data to assess the level of accuracy. The GC and XRF data will also be used qualitatively to help define the extent of soil contamination.

9.1.4.2 Subtask 4B - Data Validation

Upon completion of sample analysis, Atlantic receives the data packages from the laboratories, and validates the data prior to its evaluation. Data validation will be performed in accordance with *Sampling Chemical Analysis Quality Assurance Requirements* for the Navy Installation Restoration (IR) Program and U.S. EPA Region I Laboratory Data Validation Functional Guidelines. Any data noted in the review that should be qualified will be flagged with the appropriate symbol. Results for field blanks and field duplicates will also be reviewed and the data further qualified if necessary. The data set as a whole will also be examined for consistency, anomalous results, and whether or not the data are reasonable for the samples involved.

Any limitations on the use of the analytical data based on the data validation will be identified. Limitations of the analytical data will be presented in the Phase II RI report.

9.1.5 Task 5 - Data Evaluation

Specific analyses and evaluations to be performed under the Data Evaluation subtask will include:

- Prepare analytical data summary tables by site showing chemicals detected and screening these values to determine if they exceed ARAR/TBC values or background.

- Preparing ground water and bedrock contour maps.

- Prepare boring logs, monitoring wells, as-builts and geologic cross-sections.

- Compute hydraulic gradients and evaluate ground water flow direction.

- Calculate hydraulic conductivity based on hydraulic conductivity tests and grain size distribution.

- Compute ground water flow rates based on measured gradients, boring logs, and hydraulic conductivity results.

- Generate figures showing lateral and vertical extent of soil and ground water contamination.

9.1.6 Task 6 - Risk Assessment

The risk assessment will be consistent with the risk assessment work plan included as Section 4.0 (Human Health) and Section 5.0 (Ecological) of this Work Plan. The results of the assessment will be included as separate chapters in the Phase II RI Report.

Based on the risk assessment, preliminary cleanup levels will be developed to guide the selection of remedial measures for media where either ARARs do not exist or where the ARARs are not protective. These proposed criteria will be developed from input from U.S. EPA and CTDEP on the technical issues.

9.1.7 Task 7 - Remedial Investigation Report

A report summarizing Phase II RI activities and findings will be prepared and submitted to the U.S. EPA, CTDEP, and TRC members for review and comment. Field investigation and the analytical data will be made available to U.S. EPA and CTDEP as early as possible to aid in identification of remedial action objectives, which will be finalized during the FS. The Phase II RI report will also be submitted to the Agency for Toxic Substance and Disease Registry and the CTDOHS for their information. The Phase II RI report will be prepared in accordance with the current *RI/FS Guidance* (U.S. EPA 1988a). This report will include basewide bedrock and ground water contour maps.

All analytical data in these reports will be presented in two formats. One format is a summary of constituents and concentrations detected and the other format is more comprehensive and will be appended to the report. Examples of these formats are included as Appendix E.

Regarding field screening, qualitative results such as those from the photoionization detector will be shown in boring or sample logs. Quantitative results (XRF and GC) and soil gas data will be summarized in the body of the report with complete results tabulated in an appendix.

Complete data packages for any analytical results will be available upon request of a reviewer. For CLP parameters, the data packages will be adequate to allow EPA level IV data validation.

9.1.8 Task 8 - Remedial Action Alternative Development

The Feasibility Study will be conducted for all Step II and Supplemental Step II sites.

The purpose of developing remedial action alternatives is to produce a reasonable range of waste management options to be analyzed more fully in the detailed analysis of alternatives. Developing alternatives includes the following elements:

- Establishing remedial action objectives.
- Developing general response actions.
- Identifying and screening technologies and process options.
- Combining medium-specific technologies to form alternatives.
- Screening alternatives, if necessary.

Section 6.0 of this Work Plan presents the preliminary identification of remedial action alternatives for all investigation sites. The preliminary remedial action objectives and subsequent remedial action alternatives are based on results of the Phase I RI and preliminary work completed regarding development of the Feasibility Study for Area A/OBDA, DRMO and the Lower Subase.

These preliminary remedial action alternatives will be refined on the basis of the information collected during the Phase II RI. Additional alternatives may need to be developed depending on the findings of the risk assessment. As required, a no-action alternative will also be retained through the development and evaluation of the alternatives process.

9.1.9 Task 9 - Alternatives Evaluation

The final alternatives will be evaluated to provide the Navy with a framework with which to select a remedy for the site. The detailed analysis of these alternatives will be conducted in three stages: alternative refinement, analysis, and comparative analysis.

Further refinement of the alternatives will include developing detailed information such as:

- Identifying design parameters for technology components such as a thermal desorber and ground water treatment system.
- Quantifying amounts of contaminated soils and sediments to be handled.
- Estimating time of implementation for construction activities.
- Estimating O&M requirements, particularly for a ground water pump and

treatment system.

- Process sizing.

This information will be used to develop a cost estimate to within +50 percent to -30 percent.

During the analysis, each alternative will be evaluated with respect to the following nine evaluation criteria:

- overall protection of human health and the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume through treatment
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

Detailed descriptions of each of the above criteria are reported in the *RI/FS Guidance* (U.S. EPA 1988a).

Following the analysis, a comparative analysis will be performed. The comparative analysis will lead to the development of a description of the strengths and weaknesses of the alternatives relative to one another. Not all the criteria will be used in this evaluation; just those that illustrate significant differences among the alternatives. As part of this evaluation, there will be a sensitivity analysis to determine how a change in the uncertainties or assumptions made in the analysis may change the performance of the alternatives.

9.1.10 Task 10 - Feasibility Study Report

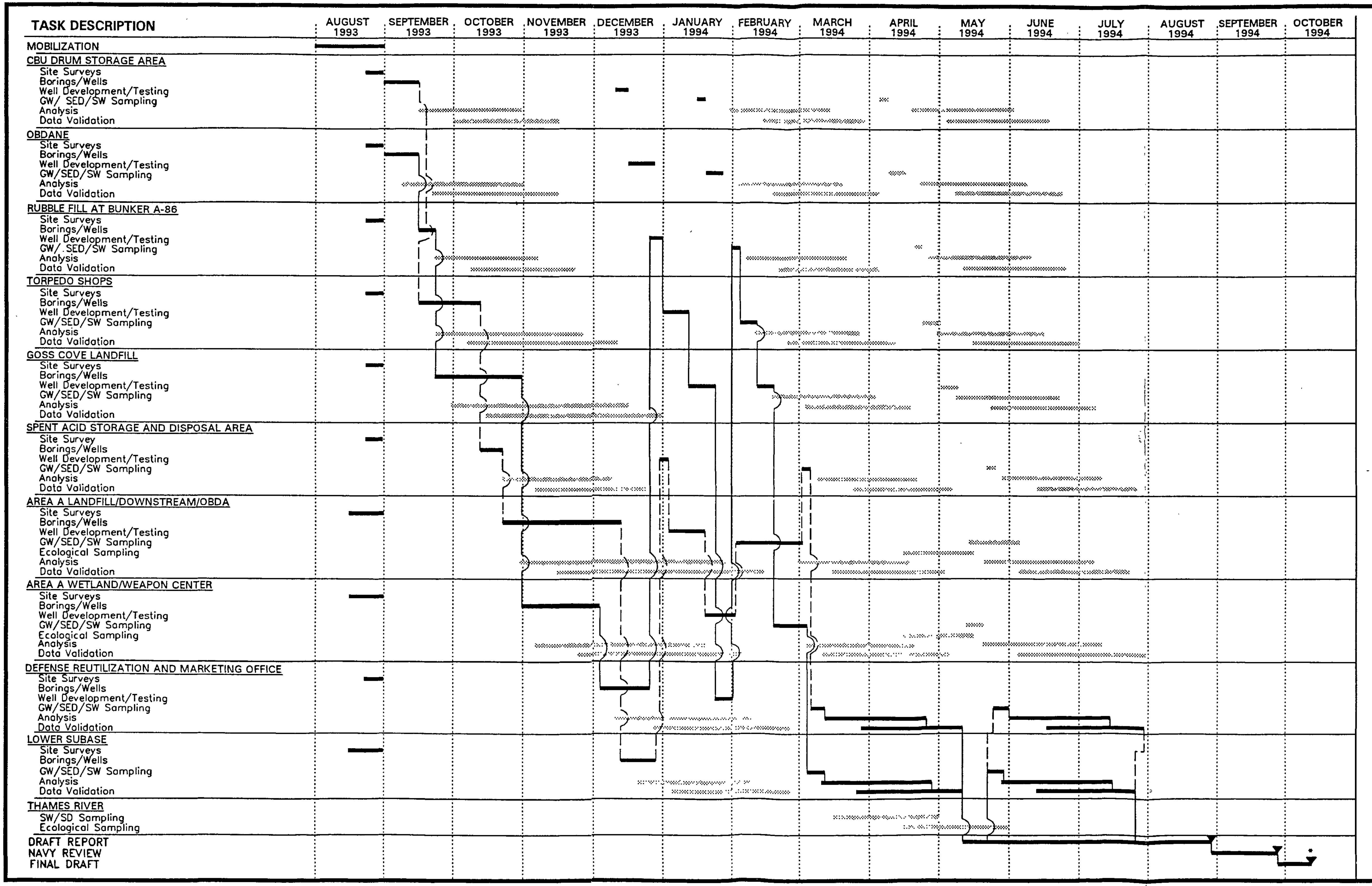
Following completion of the detailed evaluation task, Atlantic will prepare and submit a draft FS report to the Navy for review and approval. The Navy will then send copies of the report to U.S. EPA, CTDEP, and other TRC members for their review and comment. The report will summarize FS activities and RI site characterization results and will be prepared in accordance with *RI/FS Guidance* (U.S. EPA 1988a). Information developed during the FS such as identification of ARARs, detailed description of alternatives, and detailed evaluation of alternatives will be provided to U.S. EPA, CTDEP and TRC members for review as these items are completed, in order to obtain input during the evaluation process.

9.1.11 Task 11 - Treatability Studies

Any necessary laboratory, bench, or pilot scale treatability studies required to evaluate the effectiveness of remedial technologies and establish engineering criteria will be identified as early as possible. Should laboratory studies be required, a testing plan for the studies will be prepared and presented to U.S. EPA, CTDEP and other TRC members for review and approval. The testing plans will identify the types and goals of the studies, the level of effort needed, a schedule for completion, and the data management guidelines. Upon contractual approval, a test facility and any necessary equipment, vendors, and analytical services will be procured as required to implement the test plan. Upon completion of the testing, the results will be evaluated to assess the technologies with respect to the goals identified in the test plan. A report summarizing the testing program and its results will be prepared and presented in the final FS report.

10.0 SCHEDULE

The schedule for implementation of the Phase II RI at NSB-NLON is shown in Figure 10-1.



ATLANTIC ENVIRONMENTAL SERVICES, INC.

FIGURE 10-1
PROJECT SCHEDULE

- PROJECT DELIVERABLE
- CRITICAL PATH CREW 1
- CRITICAL PATH CREW 2

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

11.0 PROJECT MANAGEMENT

Specific Atlantic personnel have been identified who are responsible for implementing aspects of the project. Primary responsibility rests with the Project Manager. Figure 11-1 presents the organizational structure for this investigation at NSB-NLON.

The names and addresses of the primary contacts with the Navy are given below.

Engineer-in-Charge

Deborah Stockdale
Northern Division, Naval Facilities Engineering Command
Lester, Pennsylvania
Telephone: (215) 595-0567

Point-of-Contact

William Mansfield
Naval Submarine Base - New London
Groton, CT
Telephone: (203) 449-2276

Responsibilities of Atlantic's staff are presented in the following subsections.

11.1 Principal-in-Charge

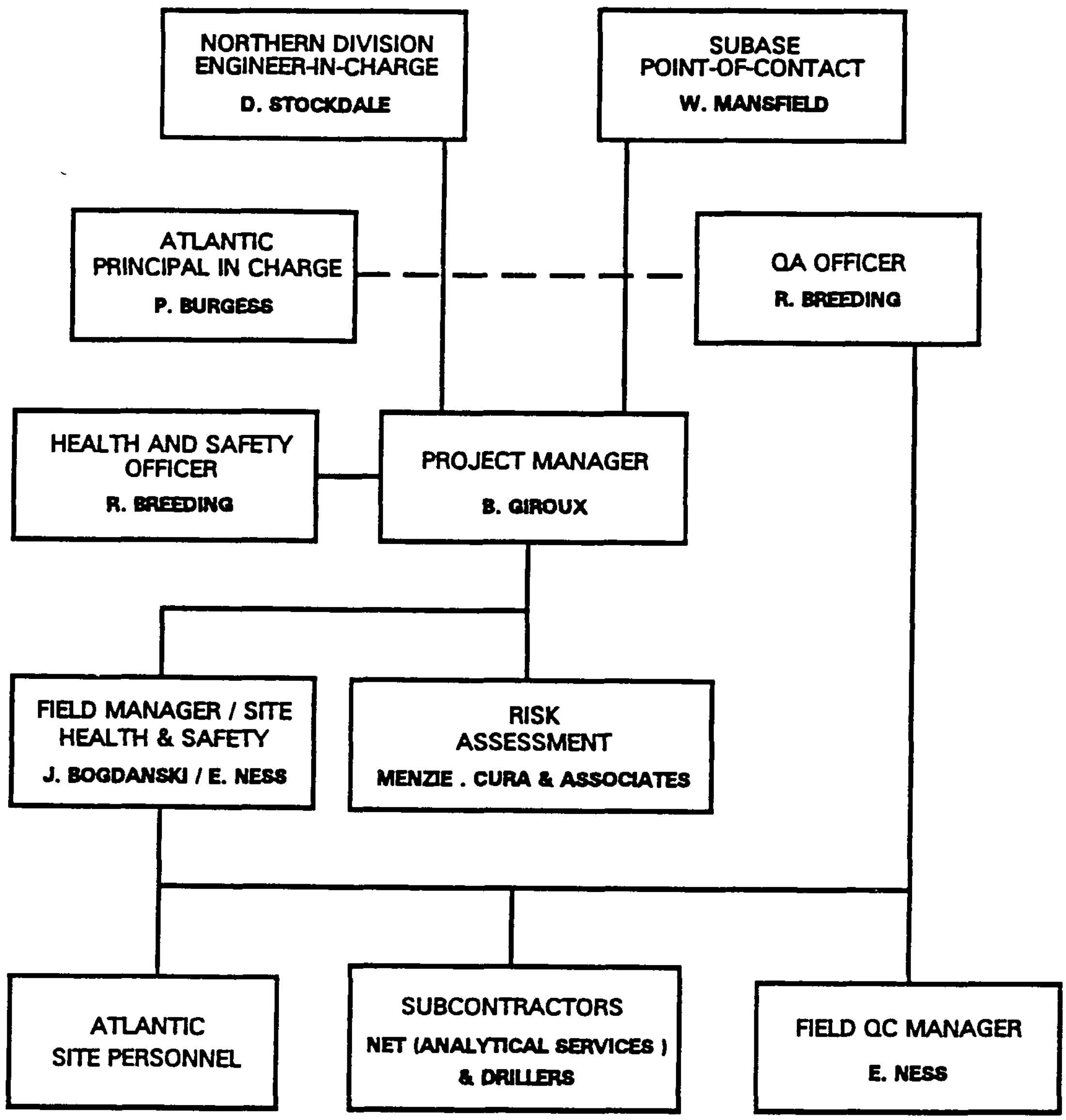
Paul Burgess is Atlantic's Principal-in-Charge for this project. As such, he is the Atlantic corporate officer who will provide final technical review of all products, ensure that all necessary materials and resources are allocated to this project, and ensure that the Navy and oversight agencies are completely satisfied with all work products.

11.2 Project Manager's Responsibility

The Atlantic Project Manager (Barry Giroux) will provide overall direction to the project team and is responsible for overall technical, financial, scheduling, and QA/QC matters. The Project Manager will be the primary contact for the Northern Division's Engineer-in-Charge (EIC) and NSB-NLON Point-of-Contact (POC).

11.3 Field Manager/Site Health & Safety

The field manager will be onsite and will implement the field sampling plan and will be responsible for worker health and safety as specified in the HASP. As such, he will be responsible for all day-to-day activities such as scheduling with subcontractors, daily logs, mobilization, demobilization, waste disposal, coordination with Navy personnel, etc.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

FIGURE 11-1
PROJECT ORGANIZATION

ATLANTIC ENVIRONMENTAL SERVICES, INC.

11.4 QA Officer's Responsibility

The Atlantic QA Officer (Robert Breeding) reports independently to Atlantic's Principal and has full authority to act independently of the technical management of the IR program. He will serve as Atlantic's primary contact with the Northern Division's QA staff, if so requested by the EIC. He will monitor compliance of the project with the QA/QC Plan and perform any necessary audits, initiate and report corrective actions, and assist in preparing QA/QC project summaries for the Final Report.

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APPENDIX A

TORPEDO SHOP BACKGROUND DATA

GZA

OTTO FUEL STORAGE EVALUATION
BUILDING 450
NAVAL SUBMARINE BASE
GROTON, CONNECTICUT

Prepared for:
Anderson-Nichols & Company, Inc.
Boston, Massachusetts

Prepared by:
Goldberg-Zoino & Associates, Inc.
Providence, Rhode Island

File No. Y-30487
N vember 1989

9509

3.00 DISCUSSION OF RESULTS/CONCLUSIONS

The following sections provide a discussion of the findings and conclusions of these evaluations.

3.10 EVALUATION OF SUBSURFACE SOIL CONTAMINATION

As discussed in Appendix B, GZA conducted a preliminary evaluation of soil contamination in the area around the abandoned waste OTTO Fuel sump and tank. Based on the studies conducted and observations made as part of this evaluation, GZA has concluded that:

* There is evidence of soil contamination in the immediate vicinity of the waste OTTO Fuel sump/tank. The compounds present include mineral spirits, acetone, Freon 113, tetrachloroethylene, and xylenes. GZA has not yet received conclusive results as to the presence of OTTO Fuel in the soil.

* The contamination was observed in soil samples collected at depths corresponding to the bottom of the tank or lower. This may indicate that the source of the contaminants i leakage from the tank. However, it is also possible that leakage may have occurred in the pipelines beneath the building and migrated within the fill or groundwater beneath the building.

3.20 EVALUATION OF FLOOR DRAIN COLLECTION SYSTEM

As presented in Appendix C, the findings of ERA's evaluation indicate the following:

* analytical results indicate the presence of OTTO Fuel II in the sump and floor drainage system. Separate liquid phases were evident in the sump and "running trap" samples. Th sump sample was obtained from a small puddle of liquid remaining in the tank after it was emptied by the Navy.

* visual observations and field HNU VOC screening results suggest the presence of VOCs such as solvents in most, if not all, of the floor drainage system lines. Elevated HNU readings were noted in the rooms located on the south sid of Building 450, where the majority of OTTO Fuel handling reportedly takes place. Visual notations on the samples flushed from the lines with IPA indicated the presence f

yellowish or greenish liquid layers, with some floating oil and settleable solids. (Note: OTTO fuel is relatively nonvolatile and the headspace over samples of pure OTTO Fuel do not yield elevated (+1.0 ppm) HNU readings).

* blockage or major leakage of piping between the safety shower drain, located in the garage outside of the handling area, and the running trap was suggested by the flush test performed in this section. When liquid was introduced into the drain, it did not appear at the trap, although building plans show a direct connection.

* due to the potential damage to the torpedo equipment and the building, as well as its negative impact on torpedo operations, ERA concluded that the preferred approach would be to clean and abandon the system in place rather than attempt to remove the piping from beneath the structure.

3.30 EVALUATION OF TEMPORARY STORAGE TANK SYSTEM

EA's review of tank system's compliance with 40 CFR 265, Subpart J, identified a number of areas of noncompliance. As discussed in their report in Appendix D, EA identified the need for:

* design and installation of the tank(s) in accordance with 265.192, which requires review and certification of the design and installation for compliance with the regulations by an independent, qualified, registered professional engineer. Issues to be addressed in this review include the structural integrity of the tank and its supports, and the compatibility of the tank material with the stored waste.

* additional secondary containment capacity to comply with the regulations.

* the installation of overfill protection controls ("e.g., level sensing devices, high level alarms,...") on the storage tanks, and appropriate leak detection equipment/alarms within the dike area.

Furthermore, it was EA's expressed opinion that the current structural support for the tank and piping is insufficient to protect against collisions from motor vehicles.

CEIMIC CORPORATION

"Chemical Analysis for Environmental Management"

HYDROCARBON FINGERPRINT

by GC/FID

Client: GZA

Client Sample ID: GZ-1 Auger Cuttings @ 9'

Laboratory ID: 890405-02

Date Sample Received: 10/27/89

Date Sample Prepared: 10/31/89

Date Sample Analyzed: 11/10/89

Matrix: Soil

Target Analyte	Sample Concentration mg/kg (ppm)*
Min ral Spirits	60
Otto Fuel	<730

* = Dry weight basis, solid = 82%

R p rted by: SPH

Approved by: [signature]

100 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900 • FAX (401) 782-8905

CEIMIC
CORPORATION

"Chemical Analysis for Environmental Management"

HYDROCARBON FINGERPRINT

by GC/FID

Client: GZA

Client Sample ID: GZ-1 S-3 5-7'

Laboratory ID: 890405-01

Date Sample Received: 10/27/89

Date Sample Prepared: 10/31/89

Date Sample Analyzed: 11/10/89

Matrix: Soil

Target Analyte	Sample Concentration mg/kg (ppm)*
Mineral Spirits	ND
Otto Fuel	<72

* = Dry weight basis, solid = 83%
ND = Not detected

Reported by: SPH

Approved by: [signature]

... R.I. 02882 • (401) 782-8900 • FAX (401) 782-8905

9509

CEIMIC
CORPORATION
"Chemical Analysis for Environmental Management"

HYDROCARBON FINGERPRINT

by GC/FID

Client: GZA

Client Sample ID: GZ-3 Anger Cuttings @ 10'

Laboratory ID: 890405-03

Date Sample Received: 10/27/89

Date Sample Prepared: 10/31/89

Date Sample Analyzed: 11/10/89

Matrix: Soil

T rget Analyte	Sample Concentration mg/kg (ppm)*
Mineral Spirits	11,000
Otto Fuel	<690

* = Dry weight basis, solid = 86%

Reported by: SPH

Approved by: [signature]

100 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900 • FAX (401) 782-8905

9509

CEIMIC CORPORATION

"Chemical Analysis for Environmental Management"

HYDROCARBON FINGERPRINT

by GC/FID

Client: GZA

Client Sample ID: Method Blank

Laboratory ID: F1031-B1

Date Sample Received: NA

Date Sample Prepared: 10/31/89

Date Sample Analyzed: 11/10/89

Matrix: Soil

Target Analyte	Sample Concentration mg/kg (ppm)*
Mineral Spirits	ND
Otto Fuel	<60

NA = Not applicable
ND = Not detected

Reported by: SPH

Approved by: [signature]

GOLDBERG-ZOINO & ASSOCIATES
320 NEEDHAM STREET
NEWTON UPPER FALLS,MA 02164
(617) 969-0050

GZA 8240 ANALYSIS PURGEABLES

JOB #:	Y-30487	DATE SAMPLED:	10/23/89
SAMPLE #:	GZ-3, Auger Cuttings	DATE TESTED:	11/14/89
LABORATORY #:	A2241S	DILUTION FACTOR:	1

PRIORITY POLLUTANT LIST 8240 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)
CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
METHYLENE CHLORIDE	ND	5
1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5
1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS-1,3-DICHLOROPROPENE	ND	5
TRICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS-1,3-DICHLOROPROPENE	ND	5
BROMOFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHYLENE	--14--	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5
ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	20
1,3-DICHLOROBENZENE	ND	20
1,4-DICHLOROBENZENE	ND	20

JOB #: Y-30487 GZA 8240 ANALYSIS PAGE - 2
SAMPLE #: GZ-3, Auger Cuttings PURGEABLES
LABORATORY #: A2241S

HAZARDOUS SUBSTANCE LIST 8240 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)
ACETONE	--110--	10
CARBON DISULFIDE	ND	5
2-BUTANONE (MEK)	ND	10
VINYL ACETATE	ND	10
2-HEXANONE (MPK)	ND	10
4-METHYL-2-PENTANONE (MIBK)	ND	10
TOTAL XYLENES	--480--	5
STYRENE	ND	5

MISCELLANEOUS 8240 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)
METHYL-t-BUTYL ETHER	ND	10
TRICHLOROFLOUROMETHANE	ND	5

IDENTIFIED NON-8240 VOLATILE COMPOUNDS:	PROBABILITY
1. 1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	90*
2. (FREON 113)	
3.	
4.	
5.	

SURROGATES	RECOVERY
1,2-DICHLOROETHANE - D4	(see comment)
TOLUENE - D8	84.1%
4-BROMOFLUOROBENZENE	101%

COMMENTS__Accurate surrogate recovery calculations could not be performed on sample GZ-3, Auger Cuttings due to the elevated level of Freon 113. The pattern of the chromatogram indicates the presence of a waste oil.

ANALYZED BY ALL REVIEWED BY EWP

LDBERG-ZOINO & ASSOCIATES
D NEEDHAM STREET
WTON UPPER FALLS,MA 02164
17) 969-0050

GZA 8240 ANALYSIS
PURGEABLES

B #:	Y-30487	DATE SAMPLED:	10/23 89
MPLE #:	GZ-1, AUGER CUTTINGS	DATE TESTED:	11/3/ 9
BORATORY #:	A20756	DILUTION FACTOR:	225

IORITY POLLUTANT LIST 40 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)
LOROMETHANE	ND	2,25
OMOMETHANE	ND	2,25
NYL CHLORIDE	ND	2,25
LOROETHANE	ND	2,25
THYLENE CHLORIDE	ND	1,12
1-DICHLOROETHENE	ND	1,12
1-DICHLOROETHANE	ND	1,12
TAL 1,2-DICHLOROETHENES	ND	1,12
LOROFORM	ND	1,12
2-DICHLOROETHANE	ND	1,12
1,1-TRICHLOROETHANE	ND	1,12
RBON TETRACHLORIDE	ND	1,12
OMODICHLOROMETHANE	ND	1,12
,2-DICHLOROPROPANE	ND	1,12
ANS-1,3-DICHLOROPROPENE	ND	1,12
ICHLOROETHENE	ND	1,1
BROMOCHLOROMETHANE	ND	1,1
1,2-TRICHLOROETHANE	ND	1,1
NZENE	ND	1,1
S-1,3-DICHLOROPROPENE	ND	1,1
OMOFORM	ND	1,1
,1,2,2-TETRACHLOROETHANE	ND	1,1
TRACHLOROETHYLENE	ND	1,1
LUENE	ND	1,1
HLOROBENZENE	ND	1,1
HYL BENZENE	ND	1,1
,2-DICHLOROBENZENE	ND	2,2 0
,3-DICHLOROBENZENE	ND	2,2 0
4-DICHLOROBENZENE	ND	2,2 0

SEE PAGE - 2 FOR REMAINING COMPOUNDS

) #:	Y-30487	GZA 8240 ANALYSIS	PAGE - 2
1PLE #:	GZ-1, AUGER CUTTINGS	PURGEABLES	
3ORATORY #:	A20759		

ZARDOUS SUBSTANCE LIST 40 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)
ETONE	ND	4,500
RBON DISULFIDE	ND	1,125
BUTANONE (MEK)	ND	4,500
NYL ACETATE	ND	4,500
HEXANONE (MPK)	ND	4,500
METHYL-2-PENTANONE (MIBK)	ND	4,500
TAL XYLENES	ND	1,125
YRENE	ND	1,125

SCELLANEOUS 40 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)
THYL-t-BUTYL ETHER	ND	2,250
ICHLOROFLOUROMETHANE	ND	4,500

ENTIFIED N-8240 VOLATILE COMPOUNDS:	PROBABILITY

RROGATES	RECOVERY
,2-DICHLOROETHANE - D4	72.8%
LUENE - D8	85.8%
BROMOFLUOROBENZENE	93.9%

MMENTS__Sample GZ-1, Auger Cuttings was diluted to perform the high level 40 EPA Method due to the presence of a petroleum distillate.

ANALYZED BY ALL ALL REVIEWED BY KW KW

9509

JOB #: Y-30487
DATE SAMPLED: 10/23/89
DATE TESTED: 10/30/89

GOLDBERG-ZOINO & ASSOCIATES
320 NEEDHAM STREET
NEWTON UPPER FALLS, MA
02164
(617) 969-0050

GZA GC SCREENING FOR VOLATILE ORGANICS IN SOILS
(CONCENTRATION - PPM, ug/gram of wet soil)

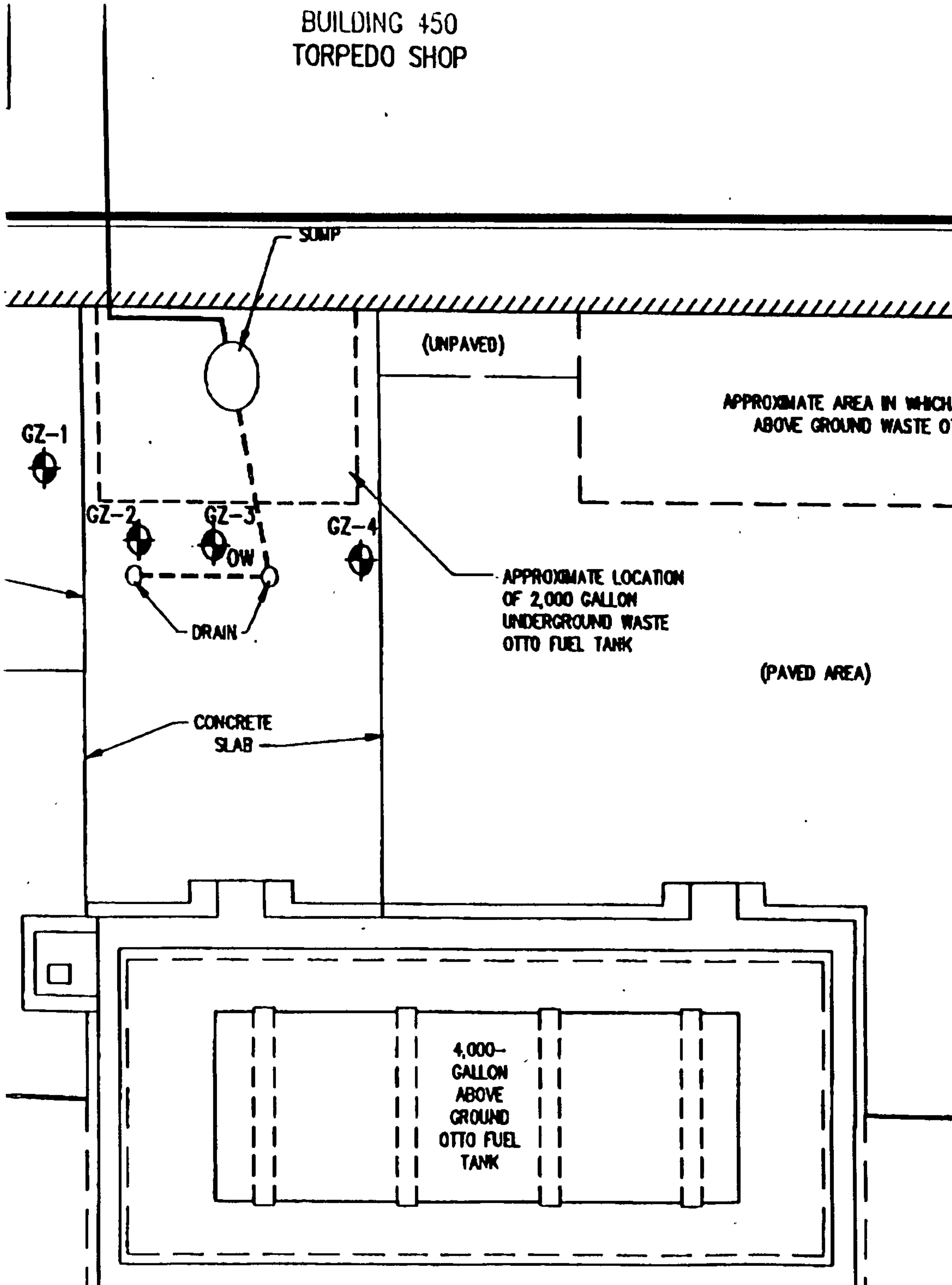
SAMPLE NAME: / GZA LAB #:	GZ-1, S-3 / 22819-Soil	GZ-3, S-3 / 22820-Soil	GZ-3, Auger Cuttings / 22821-Soil	GZ-4, S-2 / 22822-Soil	GZ-1, Auger Cuttings / 22823-Soil	METHOD DETECTION LIMIT
1. TETRACHLOROETHENE						0.02
2. TRICHLOROETHENE						0.01
3. 1,1-DICHLOROETHENE						0.01
4. TOTAL 1,2-DICHLOROETHENES						0.01
5. METHYLENE CHLORIDE						0.02
6. VINYL CHLORIDE						0.02
7. 1,1,1-TRICHLOROETHANE						0.02
8. 1,1-DICHLOROETHANE						0.01
9. 1,2-DICHLOROETHANE						0.01
10. CHLOROETHANE						0.01
11. METHYL-t-BUTYL ETHER						0.01
12. BENZENE						0.01
13. TOLUENE						0.01
14. ETHYL BENZENE						0.01
15. m,p-XYLENES						0.02
16. o-XYLENE						0.02
17. ACETONE						0.01
18. METHYL ETHYL KETONE						0.01
19. METHYL ISOBUTYL KETONE						0.01
20. CHLOROFORM						0.04
21. FREON 113 (CCl3-CF3)		0.10	0.25			0.03
22. CHLOROBENZENE						0.02
23. STYRENE						0.03
TOTAL COMPOUNDS (1-23)	ND	0.10	0.25	ND	ND	
METHANE	ND	ND	6.4	ND	9.5	
UNKNOWNS (#)	ND	Present (27)	Present (25)	ND	Present (40)	

Comments: The pattern of the chromatograms for samples GZ-3, S-3; GZ-3, Auger Cuttings and GZ-1, Auger Cuttings indicates the presence of an unknown petroleum distillate such as a fuel oil.

ANALYZED BY KW ALL 1&✓ REVIEWED BY EWP EWP

9509

2. THE LOCATIONS OF THE BORINGS WERE APPROXIM.
MEASUREMENTS FROM EXISTING TOPOGRAPHIC AND
DATA SHOULD BE CONSIDERED ACCURATE ONLY T(
METHOD USED.



LEGEND:

GZ-3 BORINGS PERFORMED BY GZA DRILLING, INC. ON O(
OBSERVED BY GZA PERSONNEL

OW- INDICATES OBSERVATION WELL INSTALLED

ANDERSON-NICHOLS
& Company, Inc.

31 ST. JAMES AVENUE, BOSTON, MA 02116 TELEPHONE: 617 695-3400

8343
file
Install Restor
Otto Fuel
Sump

25 January 1990
N62472-88-D-1405

Public Works Officer
Naval Submarine Base, New London
Groton, CT 06349-5000

Attention: Code 803 - Mr. Bill Mansfield

SUBJECT: AMENDMENT No. 9
Project No. 5; Replace OTTO FUEL WASTE SUMP
Bldg. 450, NSB, New London, CT

Gentlemen:

Per Contract N62472-88-D-1405, we are forwarding the following documents:

One (1) copy of "Air Pressure Testing of Otto II Fuel Drain System, Building 450" Report.

Very truly yours,

ANDERSON-NICHOLS & COMPANY, INC.

Robert G. Blank, P.E.

Robert G. Blank, P.E.
Project Manager

0076a

ENGINEERS · ENVIRONMENTAL CONSULTANTS · ARCHITECTS

ESTABLISHED 1922

AIR PRESSURE TESTING OF OTTO II
FUEL DRAIN SYSTEM
BUILDING 450

Navy Submarine Base, Groton, CT

Prepared for:

Goldberg Zoino Associates, Inc.
Providence, Rhode Island

Prepared by:

Environmental Resource Associates, Inc.
Warwick, Rhode Island

January 11, 1990

I. INTRODUCTION

The Naval Submarine Base located in Groton, Connecticut, includes Building 450 where Mark 48 torpedoes are tested and serviced. The building has an abandoned floor drain system for Otto II fuel consisting of approximately 1,000 linear feet of 4" cast iron, bell and spigot pipe plus a 2,000 gallon underground concrete fuel sump. Closure of the drain system and the environmental conditions in the vicinity of the building have been the subject of an on-going study. The study has demonstrated that fuel contamination exists in the drain system and all fuel floor drains are hydraulically connected except a safety shower drain. The scope of the study was extended to determine the integrity of the floor drains leading to the sump.

Environmental Resource Associates, Inc. (ERA) of Warwick, Rhode Island was contracted through Goldberg Zoino Associates, Inc. (GZA) to assess the integrity of the drain lines by pressure testing. The procedures and results obtained during the testing are presented in this report.

II. AIR TEST PROCEDURE

Available information regarding the layout and construction of the drain system was reviewed and compared to field observations conducted during an earlier phase of the study. Navy file drawings were obtained depicting known inlets and outlets in the system such as floor drains, roof vents, traps and valved connection points in the torpedo disassembly areas. A schematic of the drain system including strategic test points (numbered) is shown in Figure 1. With this knowledge, ERA developed a test procedure using air pressurization to detect leakage.

The object of the test procedure was to detect holes in the fuel drain system and translate the hole size into a maximum Otto II leakage rate. The procedure consisted of sealing all drain connections, and pumping air into the system while monitoring the air flowrate and pressure. A small leak would cause the line to slowly depressurize once the air supply is shut off. A larger leak would allow direct measurement of the air leakage at a constant pressure. All leaks in the system could be expressed as a single hole with a diameter calculated to produce an equivalent air leakage rate. By knowing the physical characteristics of air and Otto II Fuel, the leakage rate of Otto II fuel could be estimated. The field test procedure summarized below refers to locations keyed to the Drain Schematic, Figure 1.

Test Procedure

1. Pump contents of running trap into the concrete sump.

2. Using inflatable plugs, seal the running trap inlet and outlet, vent pipes, and floor drains.

3. Install a water manometer on the safety shower drain line at clean out (No. 2 in Figure 1) to measure pressure in drain line.

4. Close off all other drain inlet valves located in torpedo disassembly areas.

5. Attach the compressor, flow meter and water manometer to Floor Drain (No. 1) located in the fuel storage tank room.

6. Pressurize drain system to approximately 36" water column and check all plugs and joints (including vents and equipment) for air leakage using bubble mixture. If leakage is apparent, locate leak and correct before proceeding with test.

7. Depressurize line.

8. While recording flowrate, time, and water pressure, turn on the air compressor to again pressurize the drain line to approximately 36" water column measured at Floor Drain No. 1.

9. When pressure is reached, shut off air supply and record drain pressure with time at Floor Drain No. 1.

10. Check pressure in safety shower drain line (No. 2) to see if pneumatic connection exists with the rest of the drain system.

11. If the pressure drops slowly, repeat Steps Nos. 8, 9, 10 and 11 for a minimum of 4 hours or 4" cumulative pressure drop while under equilibrium conditions, whichever comes first.

12. If the pressure drops rapidly, record time to reach "zero" pressure. Repressurize line to various pressure drops (5 to 46" water column) while recording the flowrate of air pumped into the drain system.

13. Confirm pneumatic connection exists between Floor Drain No. 1 and other drain/vent lines by temporarily removing plugs and observing any increased pressure drop measured at Floor Drain No. 1. If necessary, set up compressor and manometers in other locations and repeat test.

14. Remove compressor and manometers.

15. Calculate equivalent hole size in piping system using above data. Calculate volume of air space pressurized during test and equivalent hole size (if leakage observed) in pressurized drain system.

16. Estimate Otto II fuel leakage rate under flooded pipe conditions.

III. ON-SITE TEST RESULTS

On-site pressure tests were run during the period 12/19 through 12/21/89 by ERA personnel. Approximately 1.5 days were spent assembling equipment, sealing lines and checking for leaks in preparation for the air tests. On 12/20 and 12/21/89 ERA performed a series of air pressure tests according to the procedure previously described.

The compressor station was set up at Floor Drain No. 1 (see Figure 1) for the first series of tests. During the tests, it was discovered that the piping system had a significant leak, requiring nearly 90 cubic feet per hour (scfh) of air to maintain a 36" head (water column pressure) in the pipe. In addition, no pneumatic connection was observed between the compressor station (No. 1) and the following stations: 1) safety shower line (as measured by manometer at No. 2), and 2) Vent Nos. 3, 6 and 7. The pressure was found to drop immediately (less than one second) to "zero" when the air supply was shut off.

In order to more completely test the lack of pneumatic communication between the various stations, the compressor station was then sequentially moved to Drain Nos. 4, 8, 9 and 12. With the compressor at Drain No. 4, no pneumatic communication was observed between Drain No. 4 and Station Nos. 2 or 5. At Drain No. 8, no communication was noted with Station No. 2. At Drain No. 9, no pneumatic communication was apparent with Drain No. 10. At Drain No. 12 in the torpedo Engine Room, no pneumatic communication was observed with Station Nos. 4, 5, 9, 10, or 13 (near the sump). At each compressor station, the measured air flowrates and pressures indicated equivalent hole sizes in the range of 0.133 to 0.143 inches diameter (see Table 1). In addition, the pressure dropped to "zero" within 0.5 seconds after removing the air supply.

As a check, the compressor assembly was then connected to the sanitary sewer drain (Station No. 11 outside the building). The air flowrates and pressure drops indicated a similar sized hole and pressure loss when the air supply was removed.

During each test, ERA personnel checked all plugs, seals and equipment to insure that they were not leaking. In addition, the building was doubly checked for any above ground drain fittings that were leaking; however, none were found. The leakage observed at each station is believed to be below grade and part of the drain system.

The volume of air space pressurized by the test was calculated by modelling the behavior of a pressurized enclosed space with an orificed outlet. Using ideal gas laws, orifice discharge relationships, calculated orifice diameter and the time noted for total depressurization, we have estimated that the volume of air space pressurized at each compressor station was no more than 0.16 cubic feet. For 3" or 4" diameter drain pipe, this would correspond to about 2 to 3 linear feet of pipe. Since the entire drain system is estimated to consist of about 1,000 linear feet of pipe, the large disparity suggests that only a small portion of the system was pressurized during each test. Given the fact that these drains exhibited hydraulic continuity during earlier flushing tests (see ERA report dated 11/14/89), the short length (2-3 ft) suggests that a trap exists at each drain location. Naval drawings, however, did not indicate that each drain was trapped.

Based upon these results, we believe that the drain system has many leaks, possibly at each pipe joint. This appears consistent with ERA's observation that the joints are lead soldered bell and spigot. Generally, this type of joint is not considered as tight as threaded or flanged connections. The tests indicate that for each 2 to 3 linear feet of pipe, an equivalent hole of 0.14" diameter exists. Since this length of pipe near the drains may encompass two pipe joints, it suggests that the equivalent hole size exists for every two pipe joints. In addition, other joints in the drain system probably experiences leakage since all the joints are of the same type.

The maximum fuel leakage rate can be estimated assuming flooded conditions in the lateral drain pipes (ie. fuel 4" deep), known physical characteristics of the fuel, the equivalent size of holes and 24 hours/day. ERA estimates that under these conditions, the maximum leakage rate is 9.7 gallons fuel per hour per every two pipe joints, or 4.9 gallons per hour per pipe joint. It must be noted that a typical pipe drain would not be completely flooded 24 hours per day, thus the actual leakage rate is probably less.

A water pressure test was not conducted due to the conclusive nature of the air test, and the Navy's concern for hazardous wastes that would be generated during the water test.

IV. CONCLUSIONS

On the basis of the above information, we believe that the following conclusions can be made:

1. Leakage was detected at all five drain locations tested in the fuel drain system.

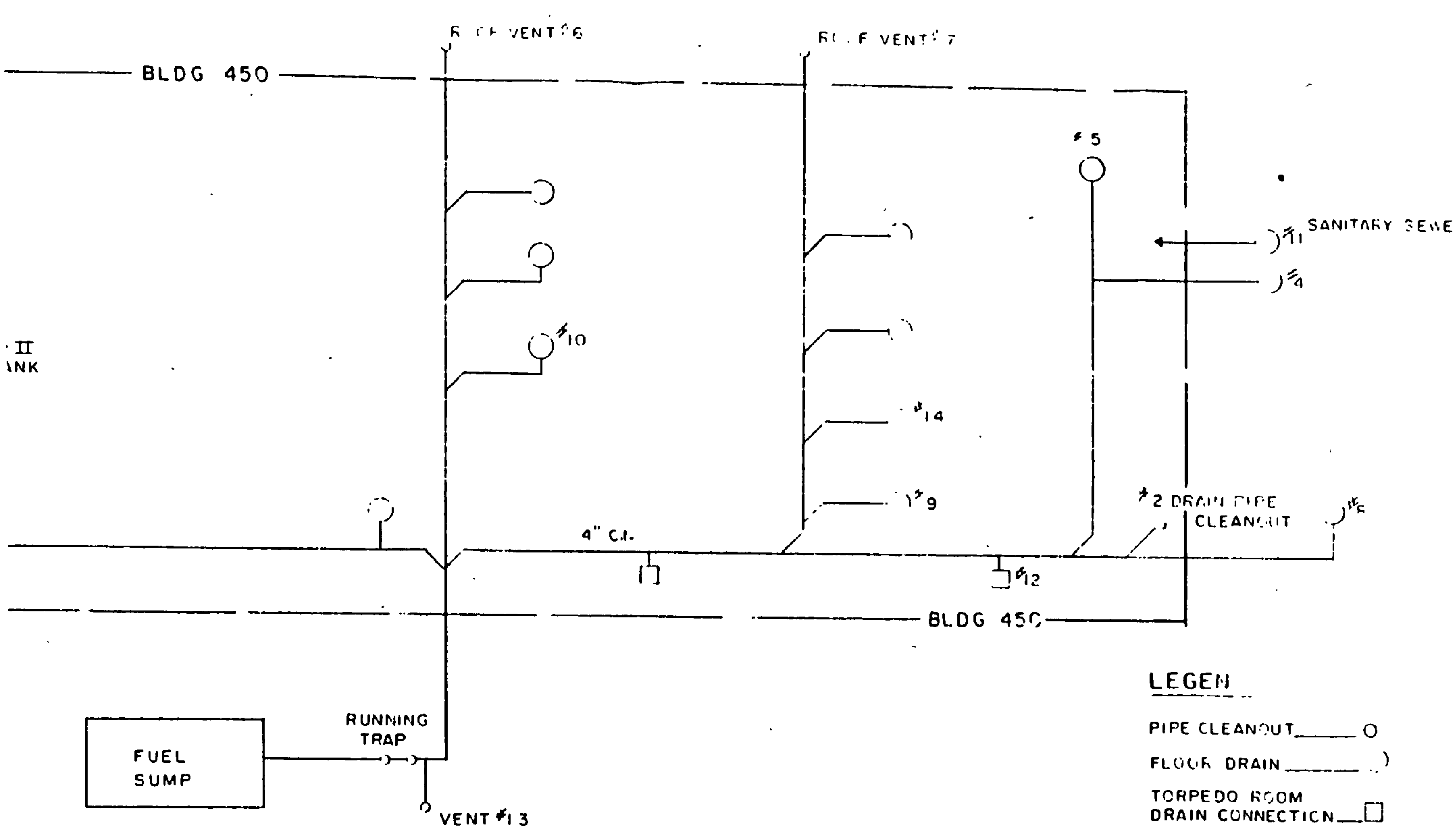
2. For each 2 to 3 linear feet of pipe nearest the tested floor drain locations, an equivalent hole of 0.14" diameter exists.

3. ERA calculates that the air test only tested the integrity of the first 2 to 3 linear feet of pipe from each drain location, representing about two pipe joints. This may be due to the existence of pipe traps not shown in floor drain construction plans given to ERA.

4. The entire system is believed to be constructed of soldered bell and spigot joints which are not generally as leak-proof as threaded, welded or flanged connections.

5. Since the entire drain system is constructed in a similar manner, it is likely that the leakage found nearest the tested floor drains is prevalent throughout the system. By projection, an equivalent hole of 0.14" diameter exists for every two pipe joints in the entire system.

6. Taking a worst case scenario by assuming the lateral drains are flooded (fuel 4" deep), the maximum fuel leakage rate in the system is estimated to be 4.9 gallons fuel per hour per pipe joint. The actual quantity may vary depending upon the condition of the pipe in those areas not amenable to testing, and actual depth and duration of fuel normally in the pipes.



ENVIRONMENTAL RESOURCE ASSOCIATES, INC.
WARWICK, R.I. (401) 781-7422

SCALE: NO SCALE	APPROVED BY	DRAWN BY TRA
DATE: 11 JAN 90		89163

SCHEMATIC OF OTTO II FUEL DRAINS - BLDG. 450
U.S. NAVY SUBMARINE BASE

GROTON, CONN.

DRAWING NUMBER
FIGURE 1

Table 1
AIR PRESSURE TEST RESULTS - OTTO FUEL DRAIN
Building 450, Groton Naval Base

Date	Station No.	Time	Measured Air Flow (scfh)	Measured Pressure (" WC)	Calculated Hole Size (Inches)
12/20/89	1	1:35	60	17	0.137
			90	33	0.143
			85	30	0.142
			80	27	0.141
			75	23	0.142
			80	27	0.141
			80	27	0.141
			75	22	0.144
			80	23	0.147
			74	19	0.148
			80	29	0.139
			80	28	0.140
			80	28	0.140
			80	28	0.140
			80	28	0.140
			80	28	0.140
			80	25	0.144
			80	27.25	0.141
			80	27.25	0.141
			80	27.25	0.141
			80	29	0.139
			82	32	0.138
			82	31.5	0.138
			80	31	0.137
			73	26	0.136
			80	30.75	0.137
			80	30.75	0.137
			89	38	0.138
			89	38	0.138
			90	38.25	0.138

Table 1
AIR PRESSURE TEST RESULTS - OTTO FUEL DRAIN
Building 450, Groton Naval Base

Date	Station No.	Time	Measured Air Flow (scfh)	Measured Pressure (" WC)	Calculated Hole Size (Inches)
			90	38.25	0.138
			89	37.5	0.138
			89	37.25	0.138
			90	38.5	0.138
			90	37.12	0.139
			89	36.5	0.139
			88	36.5	0.138
			90	37	0.139
			92	40	0.138
			91	39.75	0.138
			91	39.25	0.138
			96	52	0.133
		5:50	35	6	0.135
			50	13	0.133
			60	17.75	0.135
			70	23.5	0.137
12/21/89			92.5	39	0.140
			90	40	0.137
			90	36	0.140
			90	37	0.139
			89	38	0.138
			85	35	0.137
			75	27	0.137
			83	31	0.139
			90	40	0.137
			87	37	0.137
			82	33	0.137
			90	41	0.136

Table 1
AIR PRESSURE TEST RESULTS - OTTO FUEL DRAIN
Building 450, Groton Naval Base

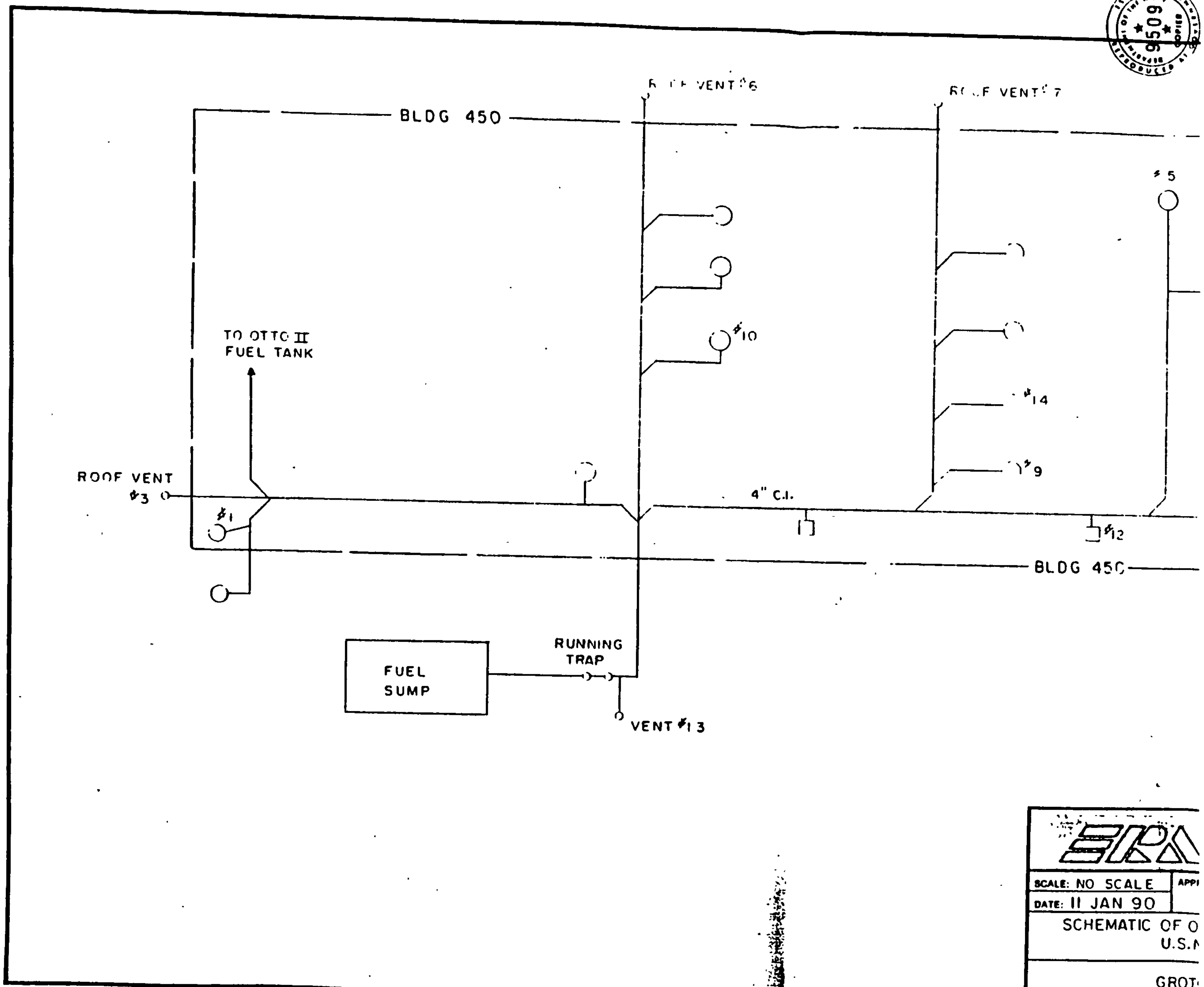
Date	Station No.	Time	Measured Air Flow (scfh)	Measured Pressure (" WC)	Calculated Hole Size (Inches)
			85	39	0.134
			91	40	0.138
			92	45	0.135
			91	41	0.137
			100	46	0.140
	4		80	36	0.132
	8		40	19	0.109
			60	21	0.130
	11		80	36	0.132
	12	3:02	85	30.5	0.142
			87	34.5	0.139
			85	34.75	0.137
			85	33.5	0.139
			85	32.75	0.139
			83	32.25	0.138
			83	31.5	0.139
			80	30.76	0.137
			82	30.5	0.139
			80	30.25	0.138
			80	30	0.138
			80	29.25	0.139
			80	28.5	0.140
			80	28	0.140
			80	27.75	0.140
			90	36	0.140
			90	35.5	0.141

Table 1
AIR PRESSURE TEST RESULTS - OTTO FUEL DRAIN
Building 450, Groton Naval Base

Date	Station No.	Time	Measured Air Flow (scfh)	Measured Pressure (" WC)	Calculated Hole Size (Inches)
			90	34.75	0.141
			88	34.26	0.140
			89	36	0.139
			89	36	0.139
			91	36	0.141
			84	31.5	0.140
			91	36	0.141
			91	35.75	0.141
			92	36.5	0.141
			42	8	0.137
			49	11.5	0.136
			70	20	0.142
			97	41.5	0.141
			92	36.5	0.141
			92	36	0.142

Table 1
AIR PRESSURE TEST RESULTS - OTTO FUEL DRAIN
Building 450, Groton Naval Base

Date	Station No.	Time	Measured Air Flow (scfh)	Measured Pressure (" WC)	Calculated Hole Size (Inches)
12/20/89	1	1:35	60	17	0.137
			90	33	0.143
			85	30	0.142
			80	27	0.141
			75	23	0.142
			80	27	0.141
			80	27	0.141
			75	22	0.144
			80	23	0.147
			74	19	0.148
			80	29	0.139
			80	28	0.140
			80	28	0.140
			80	28	0.140
			80	28	0.140
			80	28	0.140
			80	25	0.144
			80	27.25	0.141
			80	27.25	0.141
			80	27.25	0.141
			80	29	0.139
			82	32	0.138
			82	31.5	0.138
			80	31	0.137
			73	26	0.136
			80	30.75	0.137
			80	30.75	0.137
			89	38	0.138
			89	38	0.138
			90	38.25	0.138



SCALE: NO SCALE

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SCHEMATIC OF O

U.S.N

GROT

CHAPTER 3

GENERAL PROPERTIES AND HAZARDS CRITERIA

3-1. SCOPE.

3-2. This chapter presents information on the chemical nature and physical properties of Otto Fuel II. The chapter also describes the health, fire, and explosion hazards associated with Otto Fuel II.

3-3. PROPERTIES.

3-4. CHEMICAL COMPOSITION. Otto Fuel II is a stable, liquid monopropellant composed of a nitrate ester in solution with a desensitizing agent and a stabilizer. The chemical composition and specification for Otto Fuel II are listed in table 3-1 and MIL-O-82672(OS).

Table 3-1. Otto Fuel II Chemical Composition

Ingredient	Percentage	Function
Propylene glycol dinitrate	76.0	Energetic component
Dibutyl sebacate	22.5	Desensitizer
2-Nitrodiphenylamine	1.5	Stabilizer

3-5. GENERAL APPEARANCE. Otto Fuel II is a bright-red, free-flowing, oily liquid which is heavier than water; however, when in a thin layer (i.e., spill, stain, or leak), Otto Fuel II is a yellow-orange color.

3-6. CHEMICAL NATURE. Otto Fuel II is a noncorrosive liquid monopropellant with an extremely low vapor pressure which minimizes the explosive and toxic hazard. Otto Fuel II can be made to detonate, but the conditions and stimulus required are so extreme that it is considered a nonexplosive. The propellant has a high flash point and other safety characteristics which permit it to be classified as a low fire hazard material.

3-7. Solubility. Table 3-2 lists the solubilities of Otto Fuel II in various liquids. Since all components are insoluble in water, a spill washed down with water does not leave a residue more explosive than the original mixture.

Table 3-2. Solubilities of Otto Fuel II in Various Liquids

Insoluble	Slightly soluble	Very soluble
Ethylene glycol	Fuel oil	Acetone
Propylene glycol	Heptane	Alcohols
Water	Kerosene	Dibutyl phthlate
	Petroleum ether	

3-8. Stability. The decomposition of a nitrate ester, such as Otto Fuel II, is continuous and dependent upon time and temperature. The function of the stabilizing material in Otto Fuel II is to control this decomposition rate so that the fuel can remain a usable material for as long as possible. In controlling the rate of decomposition, the stabilizer reacts with the products of the nitrate ester decomposition. The products of this reaction are only slightly soluble in Otto Fuel II. Discovery of a crystalline precipitate in Otto Fuel II is go d evidence that the propellant has been exposed to unusually hig temperatures for an extended period of time.

NOTE

If a precipitate appears in Otto Fuel II, the condition should be brought to the attention of the Naval Ordnance Station, Indian Head, MD, Code 5252, as soon as it is detected, even though it does not present an immediate hazard.

3-9. Decomposition Conditions. In normal ci cumstances, the unusual decomposition conditior noted in the preceding section will never be observec Tests have shown that the fuel is thermally stable a temperatures up to 150° F for several years, up t 180° F for a few months, and up to 250° F for abour 3 minutes. Above 250° F there is serious danger of sel heating and dec mposition. At temperatures exceedin 290° F, rapid self-heating and decomposition of the fu will occur with container rupture and fire as a very likel consequence.

3-17. Air Concentrations. Individuals vary in their sensitivity to air concentration of Otto Fuel II. Normally, nasal congestion is the first sign of exposure to Otto Fuel II vapors. Otto Fuel II concentrations of less than 1.0 parts per million (ppm), but greater than 0.4 ppm, produce a complete nasal blockage in some individuals. A headache, lasting for several hours after exposure, is the chief symptom of vapor inhalation, although nausea may develop after prolonged exposure. The threshold limit value (TLV) for Otto Fuel II established by the Bureau of Medicine and Surgery of the Navy is 0.2 ppm [1.3 milligram/cubic meter (mg/m^3)] ceiling, "C". This threshold limit is established as a ceiling value, meaning it is never to be exceeded.

3-18. Combustion By-Products. The by-products from the combustion of Otto Fuel II include carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), methane (CH_4), and hydrogen cyanide (HCN). The CO, CO_2, and HCN gases present toxic hazards to personnel. See chapter 4 for more detail.

3-19. EXPLOSION. Safety tests including drop tests, projectile impact tests, bullet impact tests, and card gap tests have resulted in the classification of Otto Fuel II as a nonexplosive. However, Otto Fuel II can be detonated when a sufficiently strong booster is used. OP 5 describes Otto Fuel II as liquid propellant hazard group I, compatibility group G.

3-20. FIRE. Otto Fuel II is classified as liquid propellant hazard group I, a relatively low fire hazard, by military service regulations. Group I materials are considered to be the least hazardous of the liquid propellants.

CHAPTER 4

HEALTH AND SAFETY PRECAUTIONS

4-1. SCOPE.

4-2. This chapter presents the symptoms of overexposure to Otto Fuel II and its combustion by-products, first aid procedures, medical monitoring procedures, personnel protection measures, and fire and explosion safety precautions. BUMEDINST 6270.7A provides health precautions and guidance on protection devices for personnel exposed to Otto Fuel II.

4-3. POSTING OF SAFETY PRECAUTIONS.

4-4. Safety precautions as outlined in figure 4-1 should be posted at all locations where Otto Fuel II liquid or vapor may be contacted. A copy of these instructions is provided in appendix B. If additional copies of these instructions are needed, use figure 4-1 as a format.

4-5. PHYSICAL SYMPTOMS OF OVER-EXPOSURE TO OTTO FUEL II.

4-6. The following toxic effects may occur from the inhalation of Otto Fuel II vapors, inhalation of combustion by-products, absorption from direct skin contact, or ingestion.

a. Nasal congestion is the first sign of exposure to Otto Fuel II.

b. Headache is the chief symptom and is characterized initially by a feeling of pressure followed by a throbbing sensation.

c. A yellowish discoloration of the skin results from skin contact with Otto Fuel II.

d. Unusually low blood pressure may occur, but a more consistent finding seems to be a narrowing of the pulse pressure.

e. Severe headaches, dizziness, mental disorientation, and disequilibrium may occur from moderate overexposure.

f. Eye irritation without conjunctivitis is caused by vapor concentration of moderate to high intensity.

g. Ingestion of Otto Fuel II may cause nausea, vomiting, rapid heart beat, collapse, and death.

4-7. FIRST AID.

WARNING

In the event of overexposure to Otto Fuel II, immediately remove personnel from the contaminated area and into the fresh air. If symptoms persist, obtain medical attention as soon as possible.

4-8. In the event of overexposure to Otto Fuel II, the following first aid measures shall be taken.

4-9. INHALATION. Fresh air and a cup of hot black coffee generally alleviates the headache pain resulting from Otto Fuel II vapor inhalation. Oxygen breathing (100%) for 20 minutes or aspirin will also alleviate the headache.

WARNING

Never use solvents to cleanse Otto Fuel II from the skin because they speed absorption into the skin and accelerate and magnify the effec of the exposure.

4-10. SKIN ABSORPTION. In the event of sp contaminated clothing shall be removed immedia and contaminated skin areas shall be washed thorou with soap and warm water.

4-11. EYE CONTACT. If the eyes are splas they shall be flushed immediately with large quant of potable water for at least 15 minutes. Prc medical attention shall then be obtained.

4-12. INGESTION. Vomiting shall be induced simple emetics (e.g., soapy water solution or inser of the finger in back of the throat). Prompt medica tention shall be obtained.

4-13. **MEDICAL MONITORING.**

4-14. Preplacement, periodic, and pretermination physical examinations are required for personnel assigned tasks involving occupational exposure to Otto Fuel II in accordance with BUMEDINST 6270.7A and BUPERS transfer directives for Torpedos Mk 46 and 48 training. Occupationally exposed personnel are defined in BUMEDINST 6270.7A.

4-15. PREPLACEMENT EVALUATION. Prior to assignment to a position involving occupational exposure to Otto Fuel II, each worker shall have a health evaluation as described in BUMEDINST 6270.7A.

4-16. PERIODIC EVALUATION. A medical evaluation comparable to the preplacement evaluation shall be conducted annually on all individuals occupationally exposed to the Otto Fuel II. Additional evaluations may be performed as deemed appropriate by the responsible medical officer. If an incident has occurred with exposure of personnel to high concentrations of Otto Fuel II or if a worker has symptoms possibly related to Otto Fuel II exposure, an evaluation should be performed by the responsible medical officer.

4-17. PRETERMINATION EXAMINATIONS. Pretermination examinations shall be given before personnel are released from duty. This examination shall follow the same guidelines as the preplacement evaluation.

4-18. **PERSONNEL PROTECTION.**

4-19. PERSONNEL REQUIREMENTS AND SUPERVISION. All operations involving the handling of Otto Fuel II shall be performed by at least two persons. All personnel shall know the general characteristics of Otto Fuel II, the safety precautions to be followed, and the protective equipment required. Supervision and the conduct of operations by well-trained personnel are essential for all potentially hazardous operations involving Otto Fuel II.

4-20. SAFETY INFORMATION FOR SUPERVISORS. The supervisor shall be aware of the following indications of poor personnel safety practices:

a. Stained hands resulting from sloppy workmanship.

b. Food, drink, and tobacco present in operating areas.

c. Smoking, eating, or drinking after handling Otto Fuel II and prior to washing hands.

4-21. PERSONAL HABITS. For personnel working with Otto Fuel II, personal cleanliness is of the utmost importance. Food, drink, and tobacco shall not be permitted in Otto Fuel II operating areas because they may become contaminated and eventually will have a harmful effect on persons using them. Personnel working with Otto Fuel II shall wash their hands and faces before smoking, eating, or drinking. Personnel should shower after cleaning a major fuel spill.

4-22. GOOD HOUSEKEEPING. Good housekeeping is essential. Spills shall be cleaned up immediately. At the conclusion of operations, contaminated tools shall be thoroughly washed in a solution of water and strong detergent and wiped dry prior to storing for subsequent use. At the conclusion f fueling/defueling operations, all assembly tubes, fittings, valves, pans, etc., shall be wiped clean, placed in sealed plastic bags, and stowed in the storage area. Covered trash receptacles lined with plastic bags shall be used for Otto Fuel II contaminated rags and disp sable items. The trash receptacles and pans shall be emptied on a daily basis and the contents disposed of as Otto Fuel II waste. Only Otto Fuel II contaminated material shall be placed in Otto Fuel II waste containers. See paragraph 6-63 for disposal of contaminated material. The fuel work areas shall be kept free of all materials other than those used in the fuel operations. Frequent inspection of the work areas should be made by operational and supervisory personnel to ensure good housekeeping.

4-23. **RESPIRATORY PROTECTION.**

4-24. Ventilation or air breathing equipment is re quired for operations which present a potential inhala tion hazard to ensure that personnel are not exposed t Otto Fuel II vapor concentrations in excess of 0.2 ppm (1.3 mg/m^3) (the ceiling TLV for Otto Fuel II). Wor may be performed in atmospheres exceeding the TL only while using air breathing equipment.

WARNING

Personnel shall not position themselves between the fuel-vapor source and the local exhaust unit because the vapors will be drawn into their breathing zone.

4-25. VENTILATION. The Otto Fuel II handlir areas shall be ventilated with normal room or area ver tilation. In addition, separate local exhaust ventilatic systems positioned close to the source of Otto Fuel vapors shall be provided. The ventilation system shou

4-33. USE REQUIREMENTS. Requirements for the use of protective equipment and clothing are dependent on the degree of hazard involved. See table 4-2 for the body protective items required for each Otto Fuel II operation. An adequate supply and inventory of protective clothing and safety equipment shall be maintained at all times. A list of the required items for Otto Fuel II handling is presented in appendix C and includes the following:

a. Clothing. Clothing items consist of disposable shirts, trousers, and aprons.

WARNING

Do not use polyvinyl chloride or latex gloves, such as surgical gloves, in Otto Fuel II handling operations. These gloves provide almost no protection against Otto Fuel II.

b. Gloves. Gloves shall be worn to protect the hands from direct contact with Otto Fuel II during all handling operations. Gloves shall be replaced immediately if torn, damaged, or seriously contaminated.

c. Booties. Footwear covers shall be worn over shoes during routine working conditions whenever there is a possibility of footwear contamination by accidental spillage, splashing, or dripping of Otto Fuel II.

d. Boots. Whenever there is a gross spillage of Otto Fuel II, neoprene or natural rubber boots shall be worn for cleanup operations. The boots shall be thoroughly cleaned and decontaminated following each use with detergent and lukewarm water. Boots shall be discarded when they show signs of deterioration.

e. Eye Protection. Industrial goggles or a faceshield shall be worn whenever there is a possibility of splashing or spraying of Otto Fuel II or cleaning solvent.

4-34. DISPOSITION OF CONTAMINATED CLOTHING AND EQUIPMENT. Protective equipment need not be discarded following each use if free of contamination. Those items which are stained, contaminated, or torn shall be discarded as unsuitable for further use. Caution shall be exercised in removing and handling contaminated clothing and protective equipment to prevent exposure to the fuel. Contaminated protective clothing items and other expendables shall be tightly sealed in plastic disposal bags and disposed of as Otto Fuel II solid waste (See paragraph 6-63).

4-35. **FIRE AND EXPLOSION SAFETY.**

4-36. FIRE. Otto Fuel II has been classified as a low fire hazard. Attempts to burn Otto Fuel II in bulk at atmospheric pressure and temperatures under 250° F have been unsuccessful; however, a finely dispersed spray of Otto Fuel II may be readily ignited in an atmosphere containing oxygen. Furthermore, the propellant may be ignited in bulk when heated above 265° F. When porous or absorbent material, such as paper, rags, or fiberglass, is present to act as a wick, Otto Fuel II can be easily ignited at room temperature.

Table 4-2. Use Requirements for Protective Clothing

Operations	Protective apparel			
	Shirts, pants, and aprons	Gloves	Goggles/ faceshield	Booties
Mk 46 Torpedo				
Baffle removal	X	X	X	X
Mk 48 Torpedo				
Fuel pump priming	X	X	X	X
Mk 46 and Mk 48 Torpedo:				
Fueling/defueling	X	X	X	X
Fuel pump breakdown	X	X	X	
Afterbody breakdown	X	X	X	X
Washing or handling contaminated parts	X	X	X	X
Degreasing operation	X	X	X	X
Clean up minor fuel spills		X		
Clean up large fuel spills	X	X	X	X[1]
Retrieval operations	X	X		

[1] Boots are required for cleanup of large fuel spills.

9509

file
~~Law~~ Torpedo Shop

TO: CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION
UNDERGROUND STORAGE TANK SECTION
FAX # 566-4924

FROM: NAVAL SUBMARINE BASE NEW LONDON
ENVIRONMENTAL DIVISION
PWD BOX 400 CODE 803
GROTON, CT 06349

SUBJ: REMOVAL OF CRUSHED TANK

The attached memorandum describes actions taken yesterday on the removal of a previously unknown tank dating from the 1930's at SUBASE NLON.

CDR Burfield, FYI 17 Jul
Copy of info sent to CT DEP on tank removal.

OO

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 4
To CT DEP	From ROBERT JONES
Co. UST Section	Co. SUBASE NLON
Dept.	Phone # 449-4481
Fax # 566 4924	Fax # 2/449-5048

9509

17 Jul 92

MEMORANDUM FOR RECORD

From: Public Works Department, Enviornmental Division

Subj: REMOVAL OF ABANDONED TANK - WEAPONS COMPLEX GATE

1. During construction activities at the Naval Submarine Support Facility (NSSF) Weapons Complex gate, a suspected tank was discovered on 15 Jul. Personnel from Public Works initiated an investigation on 16 Jul by exposing a portion of the tank.

2. A search of Navy maps and plans provided no indication of placement or usage of the tank, and it was determined through interviews with employees that th the former owners of the property may have used the tank for heating a small building when the area was an active quarry in the 1930's.

3. NAVHOSP Industrial Hygiene Section performed an evaluation of the work area to insure exposure levels were acceptable for workers. NSSF Safety visited the location to evaluate safety concerns. SUBASE Environmental was present to evaluate environmental actions.

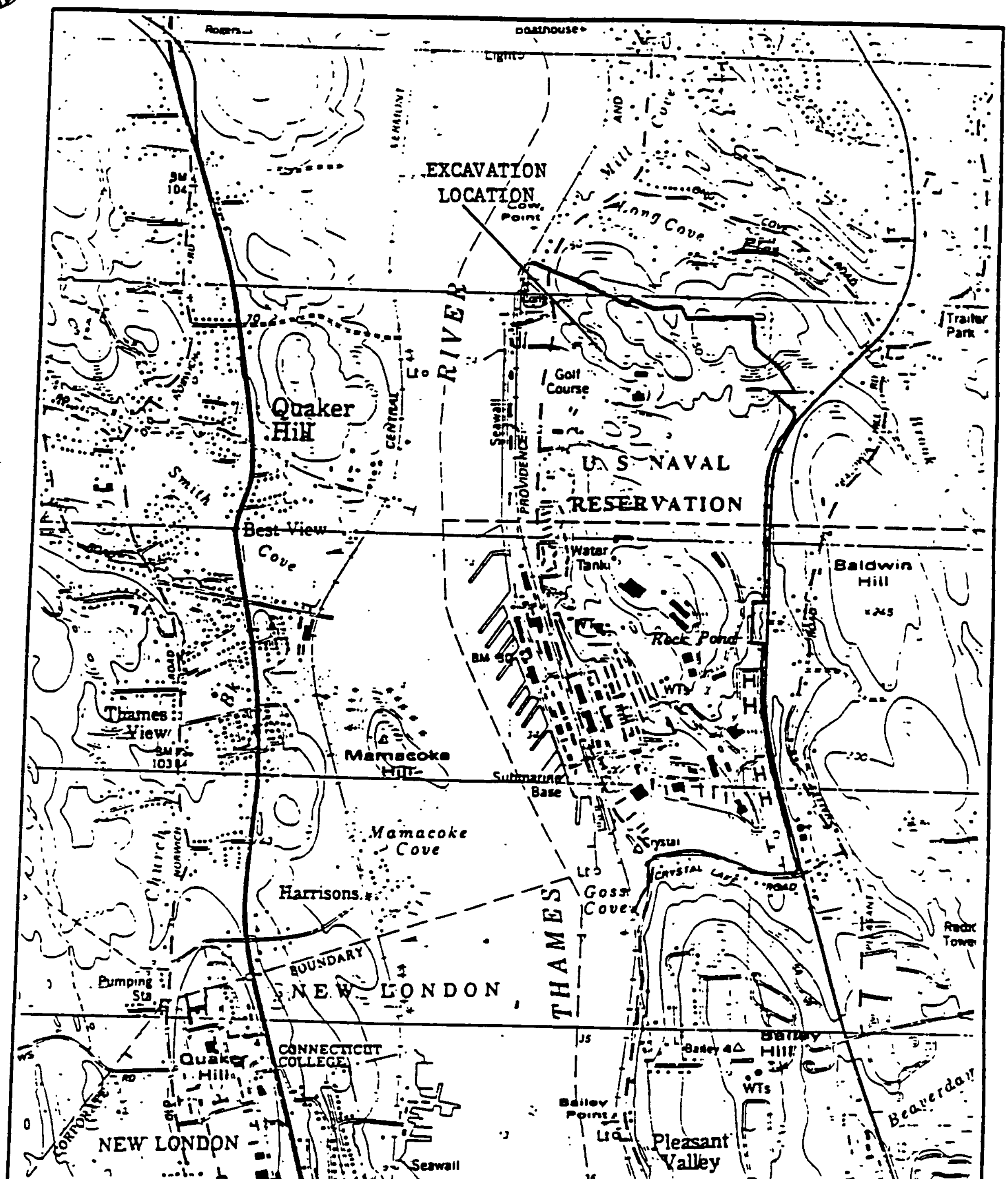
4. Intitial excavation completed at approximately 1400 hours showed the tank to be approximately 4 feet in diameter with a length of 10 feet. It was estimated that the original capacity was 1000 gallons. The tank was crushed and deformed along 6-7 feet and contained water. There were several large fist sized holes with "hundreds" of pin-hole to finger size holes. A small amount of contaminated soil was present along the west side of the tank. The Fuels Branch responded with a vacuum truck to pump out the tank. The tank immediatly refilled with water.

5. As the tank was situated beneath the NSSF Weapons Complex (Torpedo Storage) security fence adjacent to the main access road with electrical poles and fence supports almost touching the tank, it was determined to remove the tank to restore the area and allow completion of the security work.

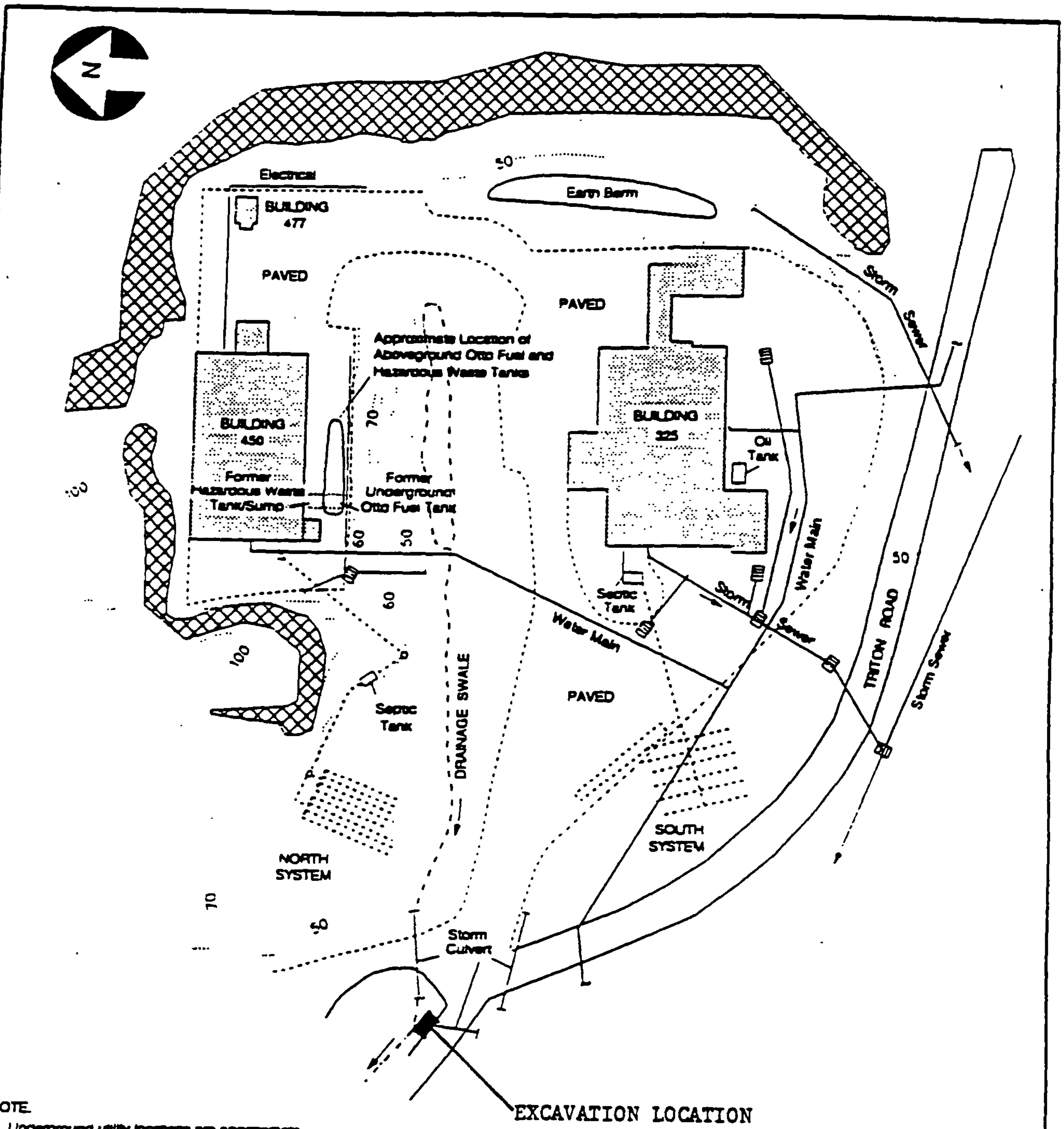
6. Using hand tools and a small backhoe, PWD personnel excavated the tank and removed it (together with the contaminated soil). The excavation was backfilled with clean sand immediately to prevent electrical transmission pol s and security fencing from collapsing into the hole. This work was completed at 1900 hours. The tank will be cleaned and removed to the Defense Reutilization and Marketing Office, Groton for use as scrap metal. The area will be identified as part of the Weapons Area study area under the Installation Restoration Program for further study to determine if past contamination has impacted the environment.

ROBERT F. JONES
Environmental Division Director

449-4481



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	SOURCE: Uncasville, Ct. U.S.G.S. Topographic Map 1984 N 0 1000 2000' SCALE	FIGURE 1-2 SITE LOCATION ATLANTIC ENVIRONMENTAL SERVICES, INC.



NOTE:

1. Underground utility locations are approximate.
2. Base map and utility information from maps of NSB-NLON prepared by Loureiro Engineering Associates, Dec 1980. Elevations are based on NSB-NLON datum which is 1.41 feet below NGVD.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND

- 95 - Existing Grade
- Exposed Bedrock
- Watercourse
- Catch Basin
- Former Septic System
- Building
- Approximate Scale: 0, 40, 80'

FIGURE 1-7
SITE PLAN
TORPEDO SHOPS

ATLANTIC ENVIRONMENTAL SERVICES, INC.

ORGANICS
ANALYTICAL DATA REPORT

WORK ORDER #

E207561

prepared for

FACILITIES SUPPORT CNTR. MAN.
BOX 400 CODE 805
NAVAL SUB BASE NEW LONDON
GROTON, CT 06349-5400

PROJECT:
9234436BH SOIL FROM REMOVAL
OF ABANDONED TANK AT WEAPONS FACILITY
16 JULY 92, SOIL STORED AT AREA 'A'.

PO:
N62472-89-D-3466
Line Items #:0001BH, 0001BJ, 0001BK, 0001BM

Date Received: 07/21/92

Prepared by

LABORATORY RESOURCES, INC.

T. F. McCommas

T.F. McCommas, Director 07/30/92
Robert LaFerriere, Tech. Lab. Director

LABOR TORY RESOURCES, INC.

EASTERN SCIENTIFIC DIVISION
RTE 205 THE REGIONAL BLDG.
P.O. BOX 700
BROOKLYN, CT 06234
TEL.-(203)774-6814 FAX-(203)774-2689

Report to: GARY ANDERSON
FACILITIES SUPPORT CNTR. MAN.
BOX 400 CODE 805
NAVAL SUB BASE NEW LONDON
GROTON, CT 06349-5400

Work ID: 9234436BH SOIL FROM REMOVAL OF ABANDONED TANK AT WEAPONS FACILITY, 16 JULY 92. SOIL STORED AT AREA 'A'

Sample #: E207561
Line Items#: 0001BH, 0001BJ, 0001BK, 0001BM
Date Received: 07/21/92 PO Number: N62472-89-D-3466

Analysis Performed	Results	Detection Limits	Date of Analysis	Method of Analysis
Sample ID: 9234436BH		Date Collected: 07/17/92		
TPH (mg/kg)	1,200	50	07/24/92	EPA 418.1

All measurements are in mg/l unless otherwise specified
ND = None Detected/Below stated detection limit

Report is an accurate analysis of sample received at this laboratory.

T. F. McCommas

T.F. McCommas, Director 07/30/92
Robert LaFerriere, Tech. Lab. Director
CT Laboratory PH 0465

95092

ORGANICS ANALYTICAL RESULTS
EPA METHOD 8010
HALOGENATED VOLATILE ORGANICS

LAB ID: E207561-01 SAMPLE MATRIX: SOLIDS
CLIENT ID: 9234436BH COLLECTED: 07/17/92
CLIENT PROJECT: 9234436BH SOIL FROM REMOVAL DATE OF ANALYSIS: 07/28/92
OF ABANDONED TANK AT WEAPONS FACILITY, 16 JULY 92
SOIL STORED AT AREA 'A'
Line Item #: 0001BK, 0001BM

PARAMETER	RESULT (ug/KG)	DETECTION LIMIT (ug/KG)
BENZYL CHLORIDE	ND	500
BROMOBENZENE	ND	500
BROMODICHLOROMETHANE	ND	500
BROMOFORM	ND	500
BROMOMETHANE	ND	1,000
CARBON TETRACHLORIDE	ND	500
CHLOROBENZENE	ND	500
CHLOROETHANE	ND	1,000
CHLOROFORM	ND	500
2-CHLOROETHYL VINYL ETHER	ND	500
CHLOROMETHANE	ND	500
DIBROMOCHLORMETHANE	ND	500
DIBROMOMETHANE	ND	500
1,3-DICHLOROBENZENE	ND	500
1,4-DICHLOROBENZENE	ND	500
1,2-DICHLOROBENZENE	ND	500
DICHLORODIFLUOROMETHANE	ND	1,000
1,1-DICHLOROETHANE	ND	500
1,2-DICHLOROETHANE	ND	500
1,1-DICHLOROETHENE	ND	500
1,2-DICHLOROETHYLENE (TOTAL)	ND	500
DICHLOROMETHANE	ND	5,000
1,2-DICHLOROPROPANE	ND	500
TRANS-1,3-DICHLOROPROPANE	ND	500
1,1,2,2-TETRACHLOROETHANE	ND	500
1,1,1,2-TETRACHLOROETHANE	ND	500
TETRACHLOROETHENE	ND	500
1,1,1-TRICHLOROETHANE	ND	500
1,1,2-TRICHLOROETHANE	ND	500
TRICHLOROETHENE	ND	500
TRICHLOROFLUOROMETHANE	ND	1,000
1,2,3-TRICHLOROPROPANE	ND	500
VINYL CHLORIDE	ND	1,000
CIS-1,3-DICHLOROPROPENE	ND	500

% Surrogate Recovery:
1,4-DICHLOROBUTANE 103%

ORGANICS ANALYTICAL RESULTS
EPA METHOD 8020
AROMATIC VOLATILE ORGANICS

LAB ID: E207561-01
CLIENT ID: 9234436BH
CLIENT PROJECT: 9234436BH SOIL FROM REMOVAL OF ABANDONED TANK AT WEAPONS FACILITY, 16 JULY 92 SOIL STORED AT AREA 'A'
Line Item #: 0001BK, 0001BM

SAMPLE MATRIX: SOLIDS
COLLECTED: 07/17/92
DATE OF ANALYSIS: 07/28/92

PARAMETER	RESULT (ug/KG)	DETECTION LIMIT (ug/KG)
MTBE	ND	500
BENZENE	ND	500
TOLUENE	ND	500
ETHYLBENZENE	ND	500
CHLOROBENZENE	ND	500
TOTAL XYLENES	ND	500
TOTAL DICHLOROBENZENES	ND	500

% Surrogate Recovery:
@,@,@-TRIFLUOROTOLUENE 79%

ORGANICS ANALYTICAL RESULTS
EPA METHOD 8080
AROCLOR PCBs

LAB ID: E207561-01
CLIENT ID: 9234436BH
CLIENT PROJECT: 9234436BH SOIL FROM REMOVAL OF ABANDONED TANK AT WEAPONS FACILITY 16 JULY 92
SOIL STORED AT AREA 'A'
Line Item #: 0001BH
DATE EXTRACTED: 07/23/92

SAMPLE MATRIX: SOLID
COLLECTED: 07/17/92
DATE OF ANALYSIS: 07/27/92

PARAMETER	RESULT (ug/KG)	DETECTION LIMIT (ug/KG)
PCB-1016	ND	500
PCB-1221	ND	500
PCB-1232	ND	500
PCB-1242	ND	500
PCB-1248	ND	500
PCB-1254	ND	500
PCB-1260	ND	500
PCB-1262	ND	500

% Surrogate Recovery:

DBC	77%

APPENDIX B

WEAPONS CENTER BACKGROUND DATA

ENVIRONMENTAL SCIENCE CORPORATION
882 Industrial Park Rd.
Middletown, CT 06457
(203) 632-0600, FAX (203) 632-7743

LABORATORY REPORT

LAB. REPORT NO.
C-12315

State Certification No. PH-0478
EPA Number CT013

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

DATE RECEIVED	07/16/91
PURCHASE ORDER NO.	AWF-137
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

GROTON

** TEST **				
	SAMPLE ID:	BELOW GRADE	ABOVE TABLE	BELOW TABLE
	LOCATION:	GROTON, CT	GROTON, CT	GROTON, CT
	TYPE:	AQUEOUS	SOIL/SOLID	SOIL/SOLID
	DATE:	/ /	/ /	/ /
	UNITS			
Cyanide, Total	mg/l	<0.02	NA	NA
Cyanide, Reactive	mg/kg	NA	<1	<1

NA - Not Analyzed   < - Below Minimum Detectable Level

Reactive Cyanide samples received 7/2/91; see report C-12148 for original analyses done on these samples.

07/24/91
DATE REPORTED

Thomas F. McGlone
LABORATORY DIRECTOR

ENVIRONMENTAL SCIENCE CORPORATION
88 Industrial Park Rd.
Middletown, CT 06457
(203) 632-0800, FAX (203) 632-7743

LABORATORY REPORT

LAB. REPORT NO.
C-12315

State Certification No. PH-0478
EPA Number CT018

DATE RECEIVED	07/16/91
PURCHASE ORDER NO.	AWP-137
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

GROTON

SAMPLE ID:	ABOVE GRADE	BELOW GRADE
LOCATION:	GROTON, CT	GROTON, CT
TYPE:	SOIL/SOLID	SOIL/SOLID
DATE:	/ /	/ /
** TEST ** (ALL UNITS ARE ug/kg)		
** EPA METHOD 8020		
Benzene	<1	<1
Chlorobenzene	<1	<1
1,2-Dichlorobenzene	<1	<1
1,3-Dichlorobenzene	<1	<1
1,4-Dichlorobenzene	<1	<1
Ethylbenzene	<1	<1
Toluene	<1	<1
Xylenes	<1	<1

< - Below Minimum Detectable Level

Reactive Cyanide samples received 7/2/91; see report C-12148 for original analyses done on these samples.

07/24/91

Thomas 7 McGlone

ENVIRONMENTAL SCIENCE CORPORATION
362 Industrial Park Rd.
Middletown, CT 06457
(203) 632-0600, FAX (203) 632-7743

LABORATORY REPORT

C-12271

State Certification No. PH-0476
EPA Number CT013

DATE RECEIVED	07/12/91
PURCHASE ORDER NO.	AWF-136
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

U.S. NAVAL BASE-Advanced Weapons Facility-N62472-87-C-0018

** TEST ** (ALL UNITS ARE mg/l)		
SAMPLE ID:	ABOVE TABLE	BELOW TABLE
LOCATION:	GROTON, CT	GROTON, CT
TYPE:	SOIL/SOLID	SOIL/SOLID
DATE:	07/02/91	07/02/91
** TCLP-Metals		
TCLP EXTRACTION		
Arsenic	<0.002	<0.002
Barium	0.21	0.23
Cadmium	<0.01	<0.01
Chromium Total	<0.01	<0.01
Lead	0.06	0.04
Mercury	<0.002	<0.002
Selenium	<0.005	<0.005
Silver	<0.01	<0.01

RECEIVED
JUL 19 1991
J.S. NASIN CO.

< - Below Minimum Detectable Level

Samples originally brought in on 7/2/91; see lab report C-12148 for original analysis done on these samples.

07/18/91
DATE REPORTED

Thomas F. McAloon

ENVIRONMENTAL SCIENCE CORPORATION
882 Industrial Park Rd.
Middletown, CT 06457
(203) 839-0600, FAX (203) 632-7743

LABORATORY REPORT

LAB. REPORT NO.
C-12148

State Certification No. PH-0476
EPA Number CT013

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

DATE RECEIVED	07/02/91
PURCHASE ORDER NO.	AWP-135
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

U.S. NAVAL BASE-Advanced Weapons Facility-N62472-87-C-0018

	SAMPLE ID: ABOVE TABLE	BELOW TABLE	
	LOCATION: GROTON, CT	GROTON, CT	
	TYPE: SOIL/SOLID	SOIL/SOLID	
	DATE: 07/02/91	07/02/91	
** TEST ** (ALL UNITS ARE mg/kg)			
**			
Arsenic	<0.04	0.044	
Barium	54.0	125	→ 100 TCLP
Cadmium	<0.38	0.51	
Chromium Total	10.5	15.1	→ 5 PPM TCLP
Lead	32.2	16.3	→ 5 PPM TCLP
Mercury	0.039	0.047	
Selenium	<0.10	<0.10	
Silver	3.1	4.8	→ 5PPM TCLP

< - Below Minimum Detectable Level

07/10/91

Thomas F. McGowan
LABORATORY DIRECTOR

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LABORATORY REPORT

LAB. REPORT NO.
C-12148

State Certification No. PH-0478
EPA Number CT013

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

DATE RECEIVED	07/02/91
PURCHASE ORDER NO.	AWF-135
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

U.S. NAVAL BASE-Advanced Weapons Facility-N62472-87-C-0018

** TEST ** (ALL UNITS ARE mg/kg)		
SAMPLE ID:	ABOVE TABLE	BELOW TABLE
LOCATION:	GROTON, CT	GROTON, CT
TYPE:	SOIL/SOLID	SOIL/SOLID
DATE:	07/02/91	07/02/91
**		
Petroleum Hydrocarbon - IR	82	90

07/10/91
DATE REPORTED

Thomas F. McGlone
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LABORATORY REPORT

LAB. REPORT NO.: C-12148

State Certification No. PH-0476
EPA Number CT013

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

DATE RECEIVED	07/02/91
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CLIENT I.D.	COMN-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

U.S. NAVAL BASE-Advanced Weapons Facility-N62472-87-C-0018

SAMPLE ID:	ABOVE TABLE	BELOW TABLE
LOCATION:	GROTON, CT	GROTON, CT
TYPE:	SOIL/SOLID	SOIL/SOLID
DATE:	07/02/91	07/02/91
** TEST ** (ALL UNITS ARE mg/kg)		
** EPA METHOD 8080/608		
4,4-DDT'	<0.1	<0.1
PCB-1016	<0.1	<0.1
PCB-1221	<0.1	<0.1
PCB-1232	<0.1	<0.1
PCB-1242	<0.1	<0.1
PCB-1248	<0.1	<0.1
PCB-1254	<0.1	<0.1
PCB-1260	<0.1	<0.1

< - Below Minimum Detectable Level

07/10/91
DATE REPORTED

Thomas F. McGlone
LABORATORY DIRECTOR

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362 Industrial Park Rd.
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LABORATORY REPORT

LAB. REPORT NO.
C-12148

State Certification No. PH-0476
EPA Number CT013

DATE RECEIVED	07/02/91
PURCHASE ORDER NO.	AWF-135
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

U.S. NAVAL BASE-Advanced Weapons Facility-N62472-87-C-0018

	SAMPLE ID:	ABOVE TABLE	BELOW TABLE
	LOCATION:	GROTON, CT	GROTON, CT
	TYPE:	SOIL/SOLID	SOIL/SOLID
	DATE:	07/02/91	07/02/91
** TEST **	(ALL UNITS ARE mg/l)		
Cyanide, Total		0.80	0.96

07/11/91
DATE REPORTED

Thomas F. McGlone
LABORATORY DIRECTOR

ENVIRONMENTAL SCIENCE CORPORATION
882 Industrial Park Rd.
Middletown, CT 06457
(203) 632-0600, FAX (203) 632-7743

LABORATORY REPORT

LAB. REPORT NO.: C-12148

State Certification No. PH-0476
EPA Number CT013

CLIENT

Mr. Robert Casey
J.S. Nasin Co.
P.O. Box 145
Willimantic, CT 06226

DATE RECEIVED	07/02/91
PURCHASE ORDER NO.	AWP-135
CLIENT I.D.	COMM-1991
CLIENT PROJECT NO.	
TELEPHONE NO.	456-4111

U.S. NAVAL BASE-Advanced Weapons Facility-N62472-87-C-0018

** TEST ** (ALL UNITS ARE mg/kg)	SAMPLE ID: ABOVE TABLE	BELOW TABLE	
LOCATION:	GROTON, CT	GROTON, CT	
TYPE:	SOIL/SOLID	SOIL/SOLID	
DATE:	07/02/91	07/02/91	
**			
Arsenic	<0.04	0.044	
Barium	54.0	125	→ 100 TCLP
Cadmium	<0.38	0.51	
Chromium Total	10.5	15.1	→ 5 PPM TCLP
Lead	32.2	16.3	→ 5 PPM TCLP
Mercury	0.039	0.047	
Selenium	<0.10	<0.10	
Silver	3.1	4.8	→ 5 PPM TCLP

< - Below Minimum Detectable Level

07/10/91
DATE REPORTED

LABORATORY DIRECTOR

05 '91 04:22PM PSI NEW HAVENTESTING P.2/3

psi Professional Service Industries, Inc.
New Haven Testing Laboratory Division

REPORT ON SOIL TOXICITY ANALYSIS

ESTED FOR:
The F. W. Brown Construction Co.
P. O. Box 857
Baltic, CT 06330

PROJECT:
Weapons Storage Improvement
U. S. Submarine Base
New London, CT

ATE: August 5, 1991

OUR REPORT NO.: 095-10442-0003

REMARKS: The following are the results of tests made on material sampled by a laboratory representative on August 2, 1991, and performed in the laboratory on August 3, 1991

Sample Id.:
620 West end, jason key port 43 MUCK LAYER
621 West end, jason key port 42 BELOW MUCK LAYER
622 East end drainway DRAINAGE SWALE
623 West of bunker 10 STORAGE PILE

1. TCLP METALS

Sample Id.:	620	621	622	623	
Arsenic	.004	ND <.001	ND <.001	ND <.001	Mg/l
Barium	.14	.05	.13	.31	Mg/l
Cadmium	ND <.01	ND <.01	ND <.01	ND <.01	Mg/l
Chromium	.02	.01	.03	.03	Mg/l
Lead	.11	.13	.09	.02	Mg/l
Mercury	.003	ND <.001	ND <.001	ND <.001	Mg/l
Selenium	ND <.001	ND <.001	ND <.001	ND <.001	Mg/l
Silver	ND <.01	ND <.01	ND <.01	ND <.01	Mg/l

2. Reactivity

Cyanide (Cn)	ND <.05	ND <.05	ND <.05	ND <.05	ppm

Professional Service Industries

The F. W. Brown Construction Co.
Weapons Storage Improvement
Report No. 095-10442-0003
August 5, 1991

3. Method 8020 - Aromatic Volatile Organics

Sample Id.:	620	621	622	623	
Benzene	ND<5	ND<5	ND<5	ND<5	ppb
Chlorobenzene					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
Ethyl benzene					
Toluene					
M-Xylene					
O-Xylene					
P-Xylene					

Tests for PCB|DDT and PAH will follow upon completion.

Respectfully submitted,
PSI/New Haven Testing Laboratory Div.
George Guiliotis

Reports: 2

b

Professional Service Industries, Inc.
New Haven Testing Laboratory Division

REPORT ON SOIL TOXICITY ANALYSIS

TESTED FOR:

F. W. Brown Construction Co.
P. O. Box 857
Baltic, CT 06330

PROJECT:

Weapons Storage Improvement
U. S. Submarine Base
New London, CT

DATE: August 13, 1991

OUR REPORT NO.: 095-10442-0003-A

REMARKS:
This report is part of Report No. 095-10442-0003 dated August 5, 1991, and should be attached to same.

Sample Id.:	620	West end, jason keyport 43
	621	West end, jason keyport 42
	622	East end drainway
	623	West of bunker 10

Sample Id.:	620	621	622	623	
4. PCB'S	NDL 2	NDL 2	NDL 2	NDL 2	ppm
5. DDT	NDL 200	NDL 200	NDL 200	NDL 200	ppb

... Phone: 203/772-0710 • Fax: 203/772-0713

W. Brown Construction Co.
roject: Weapons Storage Improvement, U.S. Submarine Base
Report No. 095-10442-0003-A
August 13, 1991

6. Polynuclear Aromatic Hydrocarbons

Sample Id.:	620	621	622	623
1. Acenaphthene	NDL 500	NDL 500	NDL 500	NDL 500 ppb
2. Acenaphthylene	"	"	"	"
3. Anthracene	"	"	"	"
4. Benzo(a)anthracene	"	"	"	"
5. Benzo(a)pyrene	"	"	"	"
6. Benzo(b)fluoranthene	"	"	"	"
7. Benzo(j)fluoranthene	"	"	"	"
8. Benzo(k)fluoranthene	"	"	"	"
9. Benzo(ghi)perylene	"	"	"	"
10. Chrysene	"	"	"	"
11. Dibenz(a,h)acridine	"	"	"	"
12. Dibenz(a,j)acridine	"	"	"	"
13. Dibenzo(a,h)anthracene	"	"	"	"
14. 7H-Dibenzo(c,g)carbazole	"	"	"	"
15. Dibenzo(a,e)pyrene	"	"	"	"
16. Dibenzo(a,h)pyrene	"	"	"	"
17. Dibenzo(a,i)pyrene	"	"	"	"

W. Brown Construction Co.
Project: Weapons Storage Improvement, U.S. Submarine Base
Report No. 095-10442-0003-A
August 13, 1991

Sample Id.:	620	620	622	623
18. Fluoranthene	NDL 500	NDL 500	NDL 500	NDL 500 ppb
19. Fluorene	"	"	"	"
20. Indeno(1,2,3-cd)pyrene	"	"	"	"
21. 3-Methylcholanthrene	"	"	"	"
22. Naphthalene	"	"	"	"
23. Phenanthrene	"	"	"	"
24. Pyrene	"	"	"	"

Respectfully submitted,
PSI/New Haven Testing Laboratory Division

CT PUBLIC ACT 88-359 CERTIFIED NO. 0319

Reports: 2
b

APPENDIX C

LEAD UPTAKE/BIOKINETIC MODEL

ON-SITE ADULT WORKER EXPOSURE TO ON-SITE SOIL LEAD CONCENTRATIONS OF 300 mg/kg

	A	B
1	Total Lead Uptake - On-Site Adult Worker	
2	GROTON NAVAL BASE	
3	Parameter	Parameter Value
4		
5	Outdoor Air Lead(µg/m3)	0.12
6	Indoor air lead (µg/m3)	0.02
7	Time spent outdoor (hrs/day)	2
8	Time weighted average (µg/m3)	=(B7*B5+(24-B7)*B6)/24
9	Volume of air respired (m3/day)	20
10	Lead intake from air (µg/day)	=B9*B8
11	% deposition/absorption in lungs	0.45
12	Air uptake from the site (µg/day)*	=(8/24)*(5/7)*1*77*0.45*0.001*p
13	Total lead uptake from lungs/no site (µg/day)	=B10*B11
14		
15	Total uptake from lungs, including site (µg/day)	=B13+B12
16		
17	Dietary lead consumption (µg/day)	13.6
18	% Absorption from gut	0.15
19	Dietary lead uptake (µg/day)	=B18*B17
20		
21	Street dust/soil lead (µg/g)	89
22	Indoor dust lead (µg/g)	119
23	Time weighted average (µg/g)	=((B7*B21)+(24-B7)*B22)/24
24	Amount of dirt ingested offsite (g/day)	0.05
25	Lead intake from offsite dirt (µg/day)	=B24*B23
26	% Dirt absorption in gut	0.25
27	Lead uptake from normal dirt intake (µg/day)	=B26*B25
28	Excess lead uptake (oral&dermal) from site (µg/day)	=50*0.001*(5/7)*0.25*ppmlead
29		
30	Total uptake from lung, skin & gut:no site exp (µg/day)	=B27+B19+B13
31	Total uptake from lung, skin & gut (µg/day)	=B28+B27+B19+B15
32		
33	Predicted blood lead: no site exposure(µg/dl)	
34	Predicted blood lead w/site exposure(µg/dl)	
35		
36	ppm lead	300
37		
38	* lead uptakes from the site are µg/day, based on weekly averages	
39	EPA 1989. Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and	
40	OAQPS Staff Report, EPA-450/2-89-011	

ON-SITE ADULT WORKER EXPOSURE TO ON-SITE SOIL LEAD CONCENTRATIONS OF 300 mg/kg

	C	D
1		
2		
3		Reference
4		
5		Site-specific data
6		EPA, 1989
7		
8		
9		
10		
11		EPA, 1989
12		
13		
14		
15		
16		
17		EPA, 1989
18		EPA, 1989
19		
20		
21		EPA, 1989
22		EPA, 1989
23		
24		
25		
26		EPA, 1989
27		
28		
29		
30		
31		
32		
33		EPA, 1989
34		EPA, 1989
35		
36		
37		
38		
39		
40		

ON-SITE ADULT WORKER EXPOSURE TO ON-SITE SOIL LEAD CONCENTRATIONS OF 300 mg/kg

	E	F
1		
2		
3	Assumptions	
4		
5		
6	urban area	
7		
8		
9		
10		
11		
12	300 ppm lead, 8 hr/day, 5 day/wk, 1 mg/m3 dust	
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28	300 ppm soil lead, 50 mg/day soil addl ingestion, 5 day/wk	
29		
30		
31		
32		
33	Harley/Kneip & Sherlock/Cools Models	
34	Harley/Kneip & Sherlock/Cools Models	
35		
36	ppm lead in soils	
37		
38		
39		
40		

APPENDIX D

PRELIMINARY REMEDIATION TARGET LEVELS

Menzie-Cura & Associates, Inc.
One Courthouse Lane
Suite 2
Chelmsford, Massachusetts 01824
Telephone (508) 453-4300
Fax (508) 453-7260

MEMO

FILE NUMBER:

TO: Barry Giroux
FROM: Charlie Menzie
DATE: March 9, 1992
SUBJECT: Target Levels for Soils at the Naval Submarine Base - New London, Groton

This memo summarizes our discussions concerning the development of target levels for soils in support of the Feasibility Study component of the Installation Restoration Study. The risk-based target levels incorporate the comments made by EPA at our February 13, 1992 meeting. At that meeting we noted that the risk assessment document was solid and we have since verified that with some sample calculations. However, we noted that in order to be consistent with EPA's most recent policies, published during and after the risk assessment work was done, we would use their suggested values to estimate target levels. Specifically, this involved: 1) using the new Cancer Potency Factor for benzo(a)pyrene, 2) using new exposure assumptions in the update to the Exposure Factors Handbook, and, 3) using the IU/BK methodology for lead. Our estimates are based on these values and not on the values used in the baseline risk assessment. This is consistent with what we discussed as a reasonable plan with EPA.

<u>Site: DRMO</u>

Synopsis: Risks to human health at DRMO were identified with respect to specific chemicals and receptors. No acute risks or imminent hazards related to the chemicals were found. However, there is ***some*** risk due to the presence of certain organic compounds - PCBs and PAH - in surface soils and lead in surface and subsurface soils. Receptor groups for which some risk was identified include: 1) workers involved in sorting scrap metal, 2) future construction workers, and, 3) workers involved in servicing underground utilities.

Target Levels for PCBs in Surface Soils

Workers at DRMO may come into contact with surface soils over long periods of time and be exposed to PCBs present within these surface soils. A Risk Reduction Objective has been identified to, "*Reduce exposure of workers to PCBs in surface soils of the DRMO.*" The objective is based on the continued industrial use of the DRMO.

Two target levels are identified for PCBs in surface soils:

- Maximum of 10 mg/kg (ppm)
- Average of 4 mg/kg

The ***maximum*** of 10 mg/kg was selected because it is consistent with levels that have been used elsewhere - including within Connecticut - to guide remediation efforts. A maximum concentration of 10 mg/kg will ensure that there are no "hot spots" for exposure to soils within the DRMO area.

The ***average*** of 4 mg/kg was selected for the area as a whole. This value would be applied to all surface areas within the DRMO as a site-wide average. The concentration, 4 mg/kg, corresponds with a 1 in 10,000 (1 E-4) cancer risk for scrap metal workers. Application of this target level as a site-wide average for DRMO will ensure that the residual risk is within the 1 E-6 to 1E-4 target range identified by EPA. Conservative assumptions have been incorporated into the estimate of risk and the derived target level should be protective of long-term scrap metal workers.

The average target level of 4 mg/kg will also ensure that risks to other receptors within DRMO are low. This target level would yield a residual risk of between 1 E-6 and 1 E-5 for frequent visitors to the DRMO that participate in the auctions and for any future construction workers. The target level would yield risks of less than 1 E-6 for utility workers.

Target Levels for Polycyclic Aromatic Hydrocarbons (PAH) Recognized as Probable Human Carcinogens (EPA Classification of B2) in Surface Soils

Workers at DRMO may come into contact with surface soils over long periods of time and be exposed to carcinogenic PAH[1] present within these surface soils. A Risk Reduction Objective has been identified to, "*Reduce exposure of workers to PAH in surface soils of the DRMO.*" The objective is based on the continued industrial use of the DRMO.

Two target levels are identified for carcinogenic PAH in surface soils:

- Maximum of 100 mg/kg (ppm)
- Average of 24 mg/kg

The ***maximum*** of 100 mg/kg was selected because it is consistent with levels that have been used elsewhere. This value was originally developed by ATSDR by Dr. Stephen Margolis. In deriving this value, ATSDR assumed that all the carcinogenic PAH were as potent as Benzo(a)pyrene. However, Dr. Margolis points out that when considering the significance of contamination at the site, the facts that all PAHs are neither carcinogenic nor (for those suspected carcinogens) as potent as Benzo(a)pyrene must be part of the evaluation.

The ***average*** of 24 mg/kg was selected for the area as a whole. This value has been derived using EPA's new cancer potency factor for Benzo(a)pyrene and that other carcinogenic PAH are as potent as BaP. The latter assumption is judged to be conservative and EPA is planning to develop an alternative method for evaluating these other PAH compounds over the course of the next year.

This average value would be applied to all surface areas within the DRMO as a site-wide average. The concentration, 24 mg/kg, corresponds with a 1 in 10,000 (1 E-4) cancer risk for scrap metal workers. Application of this target level as a site-wide average for DRMO will ensure that the residual risk is within the 1 E-6 to 1E-4 target range identified by EPA. Conservative assumptions have been incorporated into the estimate of risk and the derived target level should be protective of long-term scrap metal workers.

The average target level of 24 mg/kg will also ensure that risks to other receptors within DRMO are low. This target level would yield a residual risk of between 1 E-6 and 1 E-5 for frequent visitors to the DRMO that participate in the auctions. The target level would yield a residual risk of between 1 E-5 and 1 E-4 for future construction workers. The

---

[1]PAH compounds were evaluated with regard to carcinogenic risks and systemic (non-carcinogenic) risks. The analysis indicated that there was some carcinogenic risk but no systemic health risk. A subset of the higher molecular weight PAH compounds are considered to be probable human carcinogens (B2). The target levels apply only to these compounds as a group.

target level would yield risks of approximately 1 E-6 for utility workers.

Based on a review of the data for DRMO, soil contamination with carcinogenic PAH is very limited.

Target Level for Lead in Soils

Lead contamination of soil appears to be present in a few local areas of the DRMO. As agreed at our February 13, 1992 meeting with EPA, we have used EPA's Integrated Uptake/Biokinetic (IU/BK) Model as the basis for assessing exposure to workers at the DRMO Site. In order to do this, we modified the model slightly so that blood lead levels for adults could be estimated; the existing model only considers children. We used a blood lead level of 15 ug/dl as a target and recognize that this may be conservative with regard to effects on adults. Results are presented as ranges depending on the assumptions used and the dose-response function describing lead intake and blood lead level.

The model was run for different assumptions concerning incidental soil ingestion by workers (100 mg/day for scrap metal workers and 100 to 480 mg/day for future construction workers). For scrap metal workers, the estimated target level for lead in soils ranged between 2,400 to 4,700 mg/kg depending on the dose-response curve. For the future construction worker the rage was between 500 mg/kg and 4,500 mg/kg. The former number is based on a high continual daily soil ingestion of 480 mg/day and application of the Harley & Kneip dose-response model; the latter is based on an incidental soil ingestion rate of 100 mg/day and the Sherlock/Coole model. If an intermediate (but still conservative) soil ingestion rate of 200 mg/day is used the range is 1,200 mg/kg to 2,325 mg/kg.

Based on the back-calculated target levels for lead in soil, we suggest that a target level in the range of 1,000 to 2,000 mg/kg is probably appropriate for soils at the DRMO site. The 1,000 mg/kg level is consistent with the 500 to 1,000 mg/day target levels that have been used by ATSDR and EPA for protection of children. A target level of 2,000 mg/kg falls at the midpoint of the range derived using different exposure assumptions and models. Such a target level would be protective of workers if incidental ingestion of soil amounts to 100 mg/day using either of the dose-response models.

Lead in soils at DRMO appears to be limited to a few locations. If this contamination is addressed on a location-specific basis, average and maximum values elsewhere at the site are expected to be well within the target levels suggested above.

Target Level for Beryllium in Soils

No numerical limits have been developed for this metal. Risks are much less than those associated with other contaminants described above. In addition, it appears that remediation of soils for PCBs, PAH, and lead will address any risk reduction objectives for beryllium.

<u>Site: Area A and Downstream Watercourse</u>

Synopsis: Risks were identified in connection with the presence of PCBs in surface soils and DDTR in streambeds and wetlands. Receptors include workers involved in moving pallets and children that may play in and around the streambeds and wetlands.

Target Levels for PCBs in Surface Soils

Workers involved in moving pallets may come into contact with surface soils over long periods of time and be exposed to PCBs present within these surface soils. A Risk Reduction Objective has been identified to, "*Reduce exposure of workers to PCBs in surface soils of the Area A Landfill*".

A ***maximum*** value of 10 mg/kg is selected because it is consistent with levels that have been used elsewhere - including within Connecticut - to guide remediation efforts. A maximum concentration of 10 mg/kg will ensure that there are no "hot spots" for exposure to soils within the Area A Landfill area.

An ***average*** value of 4 mg/kg can be considered for the area as a whole and would be consistent with the target level identified for DRMO. At this average level the residual risks to receptors are as follows: less than 1 E-6 for utility workers, between 1 E-6 and 1 E-5 for children, and between 1 E-5 and 1 E-4 for workers involved in moving pallets. All these residual risks fall in the 1 E-6 to 1 E-4 target range identified by EPA.

Based on a review of the data for the Area A Landfill, it appears that all risk reduction objectives would be met by using a 10 mg/kg level as a maximum value. By remediating the few areas that may exceed this value, the overall average concentration should be well below the average target level of 4 mg/kg.

Target Level for DDTR in Sediments and Streambeds

Risks associated with exposure to DDTR were for children who might play in these areas. An average target level of 25 mg/kg for DDTR was estimated at a risk level of 1 E-6 assuming a soil ingestion rate of 200 mg/day. If a lower soils ingestion rate of 100 mg/day is assumed (as suggested by EPA's reviewers), then the target level becomes 33 mg/kg.

A target level of 25 mg/kg DDTR in sediments and soils appears to be appropriate for protection of human health at a risk level of 1 E-6.

No target levels have been developed at this time for protection of ecological receptors. EPA and U.S. FWS have indicated a need for additional data in order to identify appropriate risk reduction objectives and target levels.

The rationale for the proposed cleanup levels are based on a worker scenario rather than a residential scenario. This was the case because the receptor group for which some risk was identified was the worker. Under the assumptions used for the risk calculations, there were no risks calculated for the resident, either offsite or onsite. We believe that the target cleanup levels should be based on the risk calculations for the site and the associated site use.

We have included the equations and associated calculations that were used for determining the target levels in soils. As per guidance, we have calculated cleanup levels based upon the 10^{-4} to 10^{-6} risk range.

CALCULATIONS FOR SOILS CLEAN-UP LEVELS FOR PAHS

Clean-up Level Calculations for PAHs for the worker at DRMO

Parameters	Values	Values	Values	Values
Soil Target Level (mg/kg) based on ingestion	3.89E-01	3.89E+01	4.89E-01	4.89E+01
Soil Target Level (mg/kg) based on dermal contact	2.11E+00	2.11E+02	2.66E+00	2.66E+02
Soil Target Level (mg/kg) based on Inhalation of Fugitive Dust	1.08E+02	1.08E+04	1.36E+02	1.36E+04
Target Risk Level for cancer	1.00E-06	1.00E-04	1.00E-06	1.00E-04
CPF	7.30	7.30	5.80	5.80
Averaging period (days/yr)	365	365	365	365
Lifetime	70	70	70	70
No. of Years	35	35	35	35
days per year	180	180	180	180
Body wt	70	70	70	70
Ingestion of soil				
Soil Ingestion Rate	100	100	100	100
contaminant /soil absorption factor	1	1	1	1
conversion factor (mg/kg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Dermal Contact with Soil				
Soil Adherence Factor	0.5	0.5	0.5	0.5
Total Skin Area	19400	19400	19400	19400
fraction of Skin area exposed	0.19	0.19	0.19	0.19
dermal absorption	1.00E-02	1.00E-02	1.00E-02	1.00E-02
Inhalation of Fugitive Dust				
Pulmonary absorption	1	1	1	1
Inhalation rate	20	20	20	20
PM10 fugitive dust	0.018	0.018	0.018	0.018

EQUATIONS USED IN CALCULATIONS FOR PAH CLEANUP LEVELS

	A	B
1	Clean-up Level Calculations for PAHs for the worker at DRMO	
2		
3		
4	**Parameters**	**Values**
5		
6		
7	**Soil Target Level (mg/kg)**	**=(B16*B19*B20*B23)/(B17*B21*B22*B26*B27*B28)**
8	**based on ingestion**	
9		
10	**Soil Target Level (mg/kg)**	**=(B16*B19*B20*B23)/(B17*B21*B22*B27*B28*B31*B32*B33*B34)**
11	**based on dermal contact**	
12		
13	**Soil Target Level (mg/kg)**	
14	**based on Inhalation of Fugitive Dust**	**=(B16*B19*B20*B23)/(B17*B21*B22*B27*B28*B37*B38*B39)**
15		
16	**Target Risk Level for cancer**	0.000001
17	CPF	7.3
18		
19	Averaging period (days/yr)	365
20	Lifetime	70
21	No. of Years	35
22	days per year	180
23	Body wt	70
24		
25	**Ingestion of soil**	
26	Soil Ingestion Rate	100
27	contaminant /soil absorption factor	1
28	conversion factor (mg/kg)	0.000001
29		
30	**Dermal Contact with Soil**	
31	Soil Adherence Factor	0.5
32	Total Skin Area	19400
33	fraction of Skin area exposed	0.19
34	dermal absorption	0.01
35		
36	**Inhalation of Fugitive Dust**	
37	Pulmonary absorption	1
38	Inhalation rate	20
39	PM10 fugitive dust	0.018
40		

EQUATIONS USED IN CALCULATIONS FOR PAH CLEANUP LEVELS

	C	D
1		
2		
3		
4	**Values**	**Values**
5		
6		
7	**=(C16*C19*C20*C23)/(C17*C21*C22*C26*C27*C28)**	**=(D16*D19*D20*D23)/(D17*D21*D22*D26*D27*D28)**
8		
9		
10	**=(C16*C19*C20*C23)/(C17*C21*C22*C27*C28*C31*C32*C33*C34)**	**=(D16*D19*D20*D23)/(D17*D21*D22*D27*D28*D31*D32*D33*D34)**
11		
12		
13		
14	**=(C16*C19*C20*C23)/(C17*C21*C22*C27*C28*C37*C38*C39)**	**=(D16*D19*D20*D23)/(D17*D21*D22*D27*D28*D37*D38*D39)**
15		
16	0.0001	0.000001
17	7.3	5.8
18		
19	365	365
20	70	70
21	35	35
22	180	180
23	70	70
24		
25		
26	100	100
27	1	1
28	0.000001	0.000001
29		
30		
31	0.5	0.5
32	19400	19400
33	0.19	0.19
34	0.01	0.01
35		
36		
37	1	1
38	20	20
39	0.018	0.018
40		

EQUATIONS USED IN CALCULATIONS FOR PAH CLEANUP LEVELS

	E
1	
2	
3	
4	**Values**
5	
6	
7	=(E16*E19*E20*E23)/(E17*E21*E22*E26*E27*E28)
8	
9	
10	=(E16*E19*E20*E23)/(E17*E21*E22*E27*E28*E31*E32*E33*E34)
11	
12	
13	
14	=(E16*E19*E20*E23)/(E17*E21*E22*E27*E28*E37*E38*E39)
15	
16	0.0001
17	5.8
18	
19	365
20	70
21	35
22	180
23	70
24	
25	
26	100
27	1
28	0.000001
29	
30	
31	0.5
32	19400
33	0.19
34	0 01
35	
36	
37	1
38	20
39	0 018
40	

CALCULATIONS FOR CLEAN-UP LEVELS FOR PCBs

Clean-up Level Calculations for PCBs for the worker at DRMO		
Parameters	**Values**	**Values**
Soil Target Level (mg/kg) based on ingestion	**3.69E-01**	**3.69E+01**
Soil Target Level (mg/kg) based on dermal contact	**2.00E+00**	**2.00E+02**
Soil Target Level (mg/kg) based on Inhalation of Fugitive Dust	**1.02E+02**	**1.02E+04**
Target Risk Level for cancer	**1.00E-06**	**1.00E-04**
CPF	7.70	7.70
Averaging period (days/yr)	365	365
Lifetime	70	70
No of Years	35	35
days per year	180	180
Body wt	70	70
Ingestion of soil		
Soil Ingestion Rate	100	100
contaminant /soil absorption factor	1	1
conversion factor (mg/kg)	1.00E-06	1.00E-06
Dermal Contact with Soil		
Soil Adherence Factor	0.5	0.5
Total Skin Area	19400	19400
fraction of SI in area exposed	0.19	0.19
dermal absorption	1.00E-02	1.00E-02
Inhalation of Fugitive Dust		
Pulmonary absorption	1	1
Inhalation rate	20	20
PM10 fugitive dust	0.018	0.018

EQUATIONS USED IN THE CALCULATIONS FOR PCB CLEAN-UP LEVELS

	A	B
1	Clean-up Level Calculations for PCBs for the worker at DRMO	
2		
3		
4	**Parameters**	**Values**
5		
6		
7	**Soil Target Level (mg/kg)**	**=(B16*B19*B20*B23)/(B17*B21*B22*B26*B27*B28)**
8	**based on ingestion**	
9		
10	**Soil Target Level (mg/kg)**	**=(B16*B19*B20*B23)/(B17*B21*B22*B27*B28*B31*B32*B33*B34)**
11	**based on dermal contact**	
12		
13	**Soil Target Level (mg/kg)**	
14	**based on inhalation of Fugitive Dust**	**=(B16*B19*B20*B23)/(B17*B21*B22*B27*B28*B37*B38*B39)**
15		
16	**Target Risk Level for cancer**	**0.000001**
17	CPF	7.7
18		
19	Averaging period (days/yr)	365
20	Lifetime	70
21	No of Years	35
22	days per year	180
23	Body wt	70
24		
25	**Ingestion of soil**	
26	Soil Ingestion Rate	100
27	contaminant /soil absorption factor	1
28	conversion factor (mg/kg)	0.000001
29		
30	**Dermal Contact with Soil**	
31	Soil Adherence Factor	0.5
32	Total Skin Area	19400
33	fraction of Skin area exposed	0.19
34	dermal absorption	0.01
35		
36	**Inhalation of Fugitive Dust**	
37	Pulmonary absorption	1
38	Inhalation rate	20
39	PM10 fugitive dust	0.018
40		

EQUATIONS USED IN THE CALCULATIONS FOR PCB CLEAN-UP LEVELS

	C
1	
2	
3	
4	**Values**
5	
6	
7	**=(C16*C19*C20*C23)/(C17*C21*C22*C26*C27*C28)**
8	
9	
10	**=(C16*C19*C20*C23)/(C17*C21*C22*C27*C28*C31*C32*C33*C34)**
11	
12	
13	
14	**=(C16*C19*C20*C23)/(C17*C21*C22*C27*C28*C37*C38*C39)**
15	
16	0.0001
17	7.7
18	
19	365
20	70
21	35
22	180
23	70
24	
25	
26	100
27	1
28	0.000001
29	
30	
31	0.5
32	19400
33	0.19
34	0.01
35	
36	
37	1
38	20
39	0.018
40	

APPENDIX E

SUMMARY OF ANALYTICAL DATA PRESENTATION

REMEDIAL INVESTIGATION
CHEMICAL ANALYSIS SUMMARY FOR PESTICIDE AND PCB COMPOUNDS

****
* SAMPLE ID: NMSSGW01D01 *
****

Sample Collection Date: ____________

Lab Receipt Date: 6/25/91 Method: CLP SOW Units: UG/L Laboratory ID: 9106259-03CX

Sample Analysis Date: ____________

Analyte	Lab Result or DL		Validation Data
4,4'-DDD	U	.1100	
4,4'-DDE	U	.1100	
4,4'-DDT	U	.1100	
Aldrin	U	.0540	
Aroclor-1016	U	.5400	
Aroclor-1221	U	.5400	
Aroclor-1232	U	.5400	
Aroclor-1242	U	.5400	
Aroclor-1248	U	.5400	
Aroclor-1254	U	1.1000	
Aroclor-1260	U	1.1000	
Dieldrin	U	.1100	
Endosulfan I	U	.0540	
Endosulfan II	U	.1100	
Endosulfan sulfate	U	.1100	
Endrin	U	.1100	
Endrin ketone	U	.1100	
Heptachlor	U	.0540	
Heptachlor epoxide	U	.0540	
Lindane	U	.0540	
Methoxychlor	U	.5400	
Toxaphene	U	1.1000	
alpha-BHC	U	.0540	
alpha-Chlordane	U	.5400	
beta-BHC	U	.0540	
delta-BHC	U	.0540	
gamma-Chlordane	U	.5400	

REMEDIAL INVESTIGATION
CHEMICAL ANALYSIS SUMMARY FOR PESTICIDE AND PCB COMPOUNDS

****
* SAMPLE ID: NMSSGW01D01 *
****

Sample Collection Date: ____________

Lab Receipt Date: 6/25/91   Method: CLP SOW   Units: UG/L   Laboratory ID: 9106257-03AX

Sample Analysis Date: ____________

Analyte		Lab Result or DL	Validation Data
1,1,1-Trichloroethane	U	5.0000	
1,1,2,2-Tetrachloroethane	U	5.0000	
1,1,2-Trichloroethane	U	5.0000	
1,1-Dichloroethane	U	5.0000	
1,1-Dichloroethene	U	5.0000	
1,2-Dichloroethane	U	5.0000	
1,2-Dichloroethene (total)	U	5.0000	
1,2-Dichloropropene	U	5.0000	
2-Butanone	U	10.0000	
2-Hexanone	U	10.0000	
4-Methyl-2-Pentanone	U	10.0000	
Acetone		53.0000	53.0000U
Benzene	U	5.0000	
Bromodichloromethane	U	5.0000	
Bromoform	U	5.0000	
Bromomethane	U	10.0000	
Carbon Disulfide	U	5.0000	
Carbon Tetrachloride	U	5.0000	
Chlorobenzene	U	5.0000	
Chloroethane	U	10.0000	
Chloroform		9.0000	
Chloromethane	U	10.0000	
Dibromochloromethane	U	5.0000	
Ethylbenzene	U	5.0000	
Methylene Chloride	U	5.0000	
Styrene	U	5.0000	
Tetrachloroethene	U	5.0000	
Toluene	U	5.0000	
Trichloroethene	U	5.0000	
Vinyl Acetate	U	10.0000	UJ
Vinyl Chloride	U	10.0000	
Xylene (total)	U	5.0000	
cis-1,3-Dichloropropene	U	5.0000	
trans-1,3-Dichloropropene	U	5.0000	

REMEDIAL INVESTIGATION
CHEMICAL ANALYSIS SUMMARY FOR PESTICIDE AND PCB COMPOUNDS

****
* SAMPLE ID: NMSSGW01D01 *
****

Sample Collection Date: ____________

Lab Receipt Date: 6/25/91   Method: CLP SOW   Units: UG/L   Laboratory ID: 9106259-03AX

Sample Analysis Date: ____________

Analyte		Lab Result or DL	Validation Data	Analyte		Lab Result or DL	Validation Data
1,2,4-Trichlorobenzene	U	10.0000		1,2-Dichlorobenzene	U	10.0000	
1,3-Dichlorobenzene	U	10.0000		1,4-Dichlorobenzene	U	10.0000	
2,4,5-Trichlorophenol	U	50.0000		2,4,6-Trichlorophenol	U	10.0000	
2,4-Dichlorophenol	U	10.0000		2,4-Dimethylphenol	U	10.0000	
2,4-Dinitrophenol	U	50.0000		2,4-Dinitrotoluene	U	10.0000	
2,6-Dinitrotoluene	U	10.0000		2-Chloronaphthalene	U	10.0000	
2-Chlorophenol	U	10.0000		2-Methylnaphthalene	U	10.0000	
2-Methylphenol	U	10.0000		2-Nitroaniline	U	50.0000	
2-Nitrophenol	U	10.0000		3,3'-Dichlorobenzidine	U	20.0000	
3-Nitroaniline	U	50.0000		4,6-Dinitro-2-Methylphenol	U	50.0000	
4-Bromophenyl-phenylether	U	10.0000		4-Chloro-3-Methylphenol	U	10.0000	
4-Chloroaniline	U	10.0000		4-Chlorophenyl-phenylether	U	10.0000	
4-Methylphenol	U	10.0000		4-Nitroaniline	U	50.0000	
4-Nitrophenol	U	50.0000		Acenaphthene	U	10.0000	
Acenaphthylene	U	10.0000		Anthracene	U	10.0000	
Benzo(a)Anthracene	U	10.0000		Benzo(a)Pyrene	U	10.0000	
Benzo(b)Fluoranthene	U	10.0000		Benzo(g,h,i)Perylene	U	10.0000	
Benzo(k)Fluoranthene	U	10.0000		Benzoic Acid	U	50.0000	
Benzyl Alcohol	J	3.0000		Butylbenzylphthalate	U	10.0000	
Chrysene	U	10.0000		Di-n-Butylphthalate	U	10.0000	
Di-n-Octyl Phthalate	U	10.0000		Dibenz(a,h)Anthracene	U	10.0000	
Dibenzofuran	U	10.0000		Diethylphthalate	U	10.0000	
Dimethyl Phthalate	U	10.0000		Fluoranthene	U	10.0000	
Fluorene	U	10.0000		Hexachlorobenzene	U	10.0000	
Hexachlorobutadiene	U	10.0000		Hexachlorocyclopentadiene	U	10.0000	
Hexachloroethane	U	10.0000		Indeno(1,2,3-cd)Pyrene	U	10.0000	
Isophorone	U	10.0000		N-Nitroso-Di-n-Propylamine	U	10.0000	
N-Nitrosodiphenylamine (1)	U	10.0000		Naphthalene	U	10.0000	
Nitrobenzene	U	10.0000		Pentachlorophenol	U	50.0000	
Phenanthrene	U	10.0000		Phenol		19.0000	
Pyrene	U	10.0000		bis(2-Chloroethoxy)Methane	U	10.0000	
bis(2-Chloroethyl)Ether	U	10.0000		bis(2-Chloroisopropyl)Ether	U	10.0000	
bis(2-Ethylhexyl)Phthalate	U	10.0000					

REMEDIAL INVESTIGATION
CHEMICAL ANALYSIS SUMMARY FOR PESTICIDE AND PCB COMPOUNDS

****
* SAMPLE ID: NMSSGW01D01 *
****

Sample Collection Date: ____________

Lab Receipt Date: 6/25/91 Method: CLP SOW Units: UG/L Laboratory ID: 06259-03S

Sample Analysis Date: ____________

Analyte		Lab Result or DL	Validation Data
Aluminum		2100.0000	J
Antimony	U	30.0000	UJ
Arsenic	B	4.1000	J
Barium		4260.0000	J
Beryllium	U	1.0000	UJ
Cadmium	U	3.0000	UJ
Calcium		185000.0000	J
Chromium		62.9000	J
Cobalt	B	6.0000	J
Copper		29.6000	J
Cyanide	U	5.0000	UJ
Iron		1190.0000	J
Lead		5.4000	J
Magnesium	B	874.0000	J
Manganese		17.5000	J
Mercury	U	.2000	UJ
Nickel	B	31.0000	J
Potassium		149000.0000	J
Selenium	U	2.0000	UJ
Silver	U	5.0000	UJ
Sodium		614000.0000	J
Thallium	U	10.0000	UJ
Vanadium	U	5.0000	UJ
Zinc		80.4000	J

TABLE 4-34
AREA A DOWNSTREAM AND OBDA
SUMMARY OF GROUND WATER ANALYTICAL DATA (ORGANICS)

PARAMETER	ARARs/TBC	SAMPLE ID:	2DMW10D	2DMW11S	2DMW11D	2DMW15D	2DMW16S	2DMW16D	3MW12S	3MW12D
TCL VOLATILE ORGANICS (ppb)										
1,2-Dichloroethene (total)	70 ARAR	MCL	ND	ND	ND	ND	ND	13	ND	ND
Trichloroethene	5 ARAR	MCL	ND	ND	ND	ND	ND	17	ND	ND
1,1,2,2-Tetrachloroethane	0.17 TBC	WQC	ND	ND	ND	ND	ND	7	ND	ND
Total Volatile Organics								37		
TCL SEMI-VOLATILE ORGANICS (ppb)										
Phthalates										
bis(2-ethylhexyl)phthalate	--		4 J	ND	ND	ND	ND	ND	ND	ND
TCL PESTICIDES/PCBs (ppb)										
TCL Pesticides/PCBs	--		ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

1) ARARs/TBC indicates applicable or relevant and appropriate requirements; TBC indicates to be considered values (refer to Section 4.2 for further explanation). Shaded numbers exceed ARAR/TBC values.
2) Assigned letters adjacent to numerical values are data qualifiers. Refer to Section 2.11 for further explanation.
3) ppb indicates a concentration of parts per billion; ppm is parts per million.
4) ND means not detected, less than detection limit. Refer to Section 2.2 for further explanation. NA indicates not analyzed.
5) Only the parameters detected are listed above, all others were not detected.
6) The acronym adjacent to the ARAR/TBC value indicates the source of the value. Refer to Table 4-2 or glossary for further explanation.

TABLE 4-35
AREA A DOWNSTREAM AND OBDA
SUMMARY OF GROUND WATER ANALYTICAL DATA (INORGANICS AND RADIOLOGICAL)

PARAMETER	ARARs/TBC	SAMPLE ID:	2DMW10D	2DMW11S	2DMW11D	2DMW15D	2DMW16S	2DMW16D	3MW12S	3MW12D
TAL INORGANICS (ppb)										
Aluminum	200 TBC	SMCL	ND J	ND	ND	44.5 BJ	ND	ND	ND	ND
Antimony	5 TBC	PMCl	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	50 ARAR	MCL	ND	ND	ND	ND	ND	ND	ND	ND
Barium[7]	1000 ARAR	MCL	39.6 B	29.4 B	104 B	31.6 B	17.1 B	97.1 B	39.2 B	44.4 B
Beryllium	1 TBC	PMCL	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	5 ARAR	MCL	ND	ND	ND	ND	ND	5.1	ND	16 J
Calcium	--		22300 J	41200	42400	7340	32400	196000	64900	69400
Chromium[7]	50 ARAR	MCL	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	--		ND	ND	ND	ND	ND	ND	14.1 B	16 B
Copper[7]	1000 ARAR	MCL	ND J	5 BJ	ND	ND	ND	6.3 B	ND	ND
Iron	300 TBC	SMCL	287 J	101 J	16900	83.4 BJ	669 J	11600	1580	7090
Lead	15 ARAR	Action Level	ND J	ND	ND J	ND J	ND J	ND J	ND J	ND J
Magnesium	--		8960 J	15600	11400	3400 B	5260	28800	50900	52000
Manganese	50 TBC	SMCL	106 J	1150	2390	49.7	339	2190	6010	6770
Mercury	2 ARAR	MCL	ND	ND J	ND	ND	ND J	ND	ND J	ND
Nickel	100 TBC	PMCL	20.7 BJ	15.2 BJ	19.2 BJ	19.2 BJ	20.5 BJ	33.4 BJ	19.7 BJ	24.2 BJ
Potassium	--		5000	7210	7780	4440 B	2520 B	12600	14300	14900
Selenium[7]	10 ARAR	MCL	ND	ND	ND	ND	ND	1.8 B	ND	2.5 B
Silver[7]	50 ARAR	MCL	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	28000 TBC	Notif. Level	88800	190000	194000	57200	44500	319000	478000	560000
Thallium	1 TBC	PMCL	ND	ND R	ND	ND	ND R	ND	ND R	ND
Vanadium	20 TBC	USEPA HA	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	5000 TBC	SMCL	8.1 BJ	6.7 BJ	6.1 BJ	4 BJ	22.8 J	23.3 J	14.4 BJ	10.4 BJ
Boron	600 TBC	USEPA HA	6900 J	7500	1600	3400	2200	11000	11000	11000
Cyanide[7]	200 ARAR	MCL	ND	ND J	ND	ND	ND J	ND J	ND J	ND
RADIOLOGICAL CONSTITUENTS (pCi/L)										
Gross Alpha[7]	5	Screening Level	3.1	18.5	8.9	2.1	0.2	1.5	25.7	29.3
Gross Beta	50	Screening Level	7.5	7.7	18.3	5.6	5.1	32.8	2.8	34.1

NOTES:

1) ARARs/TBC indicates applicable or relevant and appropriate requirements; TBC indicates to be considered values (refer to Section 4.2 for further explanation). Shaded numbers exceed ARAR/TBC values.
2) Assigned letters adjacent to numerical values are data qualifiers. Refer to Section 2.11 for further explanation.
3) ppb indicates a concentration of parts per billion; ppm is parts per million.
4) ND means not detected, less than detection limit. Refer to Section 2.2 for further explanation. NA indicates not analyzed.
5) Radiological constituent values have an assigned +/- range due to sample interference.
6) The acronym adjacent to the ARAR/TBC value indicates the source of the value. Refer to Table 4-2 or glossary for further explanation.
7) These values are base on CTDOHS MCLs which are lower than USEPA MCLs. CTDOHS may at some future time revise their MCLs to correspond to U.S. EPA's.

NOTE:

1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB–NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB–NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
4. THE LOCATION OF BORINGS 27TB28 THROUGH 27TB32 (NEAR CONCRETE PAD) AND SURFACE SOIL SAMPLES 2DSS19 THROUGH 2DSS23 (IN DOWNSTREAM AREA) WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF SOURCE AREAS.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

LEGEND

EXIST.	PROP.	
6MW1	7MW5	MONITORING WELL
6TB1	7TB5	TEST BORING
2DSD1	2DSD5	SEDIMENT SAMPLE
6SS1	7SS5	SURFACE SOIL SAMPLE
2DSW1	2DSW5	SURFACE WATER SAMPLE
		DRAWDOWN OBSERVATION WELL

---10---	EXIST CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—	STORM SEWER

PLATE 1
FIELD SAMPLING PLAN
AREA A

ATLANTIC ENVIRONMENTAL SERVICES, INC.